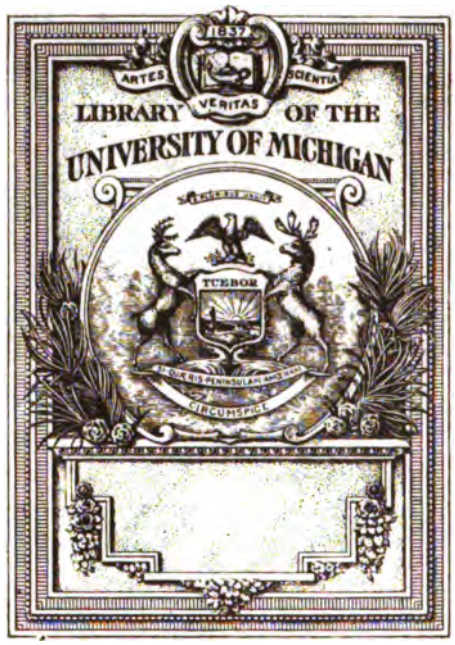
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A MONOGRAPH
ON

The Epidemic of Poliomyelitis (Infantile Paralysis)

IN NEW YORK CITY IN 1916

Based on the Official Reports of the Bureaus of the Department of Health

PUBLISHED UNDER THE DIRECTION OF THE
DEPARTMENT OF HEALTH OF
NEW YORK CITY

1917

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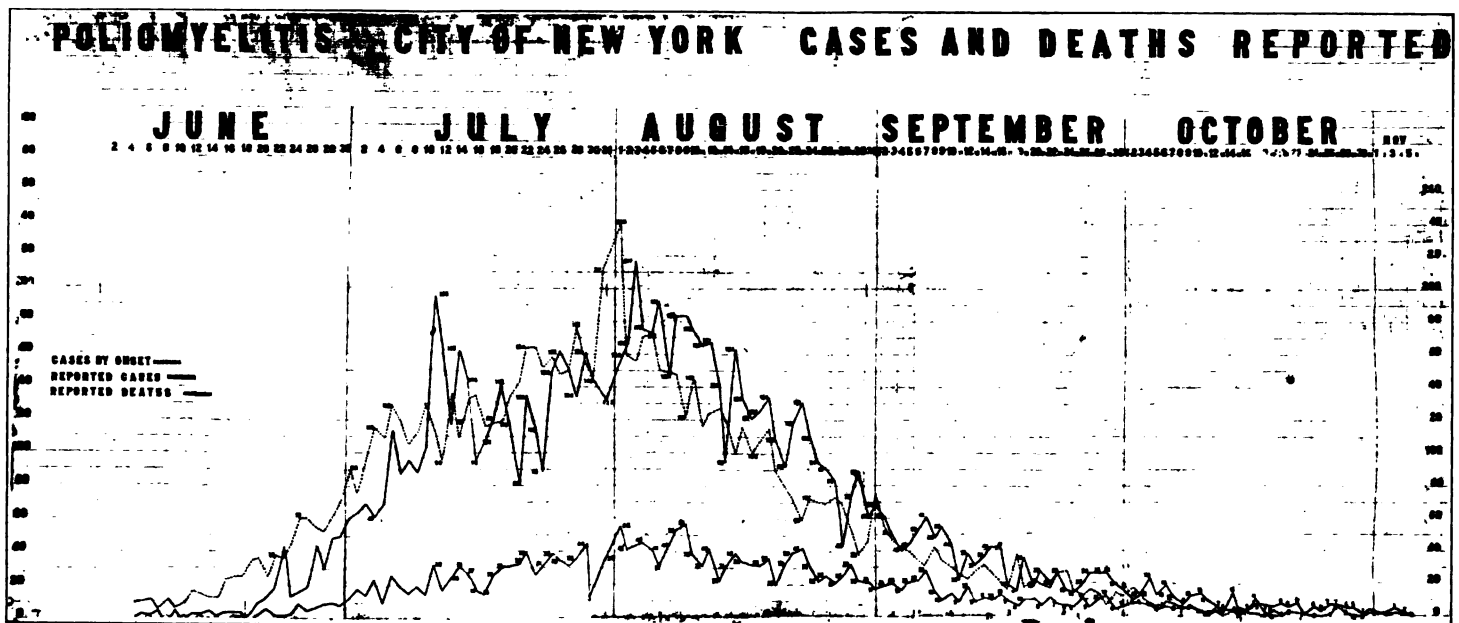
POLIOMYELITIS - CITY OF NEW YORK CASES AND DEATHS REPORTED
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
CASES BY ONSET
REPORTED CASES
REPORTED DEATHS

BOARD OF HEALTH.

HAVEN EMERSON, M. D.,
Commissioner of Health and President of the Board.

ARTHUR WOODS,
Police Commissioner.

L. E. COFER, M. D.,
Health Officer Port of New York.

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INTRODUCTION.

To:

His Honor the Mayor,
The Board of Estimate and Apportionment,
The People of New York City.

This report of the poliomyelitis epidemic is submitted as the record of an event of importance to the science of medicine and touching closely the life and happiness of individuals of this community.

Our present ignorance of such facts as will permit of a control of this epidemic disease imposes a special duty to record all data which may conceivably be of value or prove of service in the further study and solution of the many questions which must be answered before we can give assurance that a repetition of a similar epidemic can be prevented.

The data are presented so far as our present understanding permits in a way to render possible the widest use of the observations of the officers of the Department of Health by those engaged in the study, teaching and practice of preventive medicine.

It is expected that the intelligent lay reader, as well as the large group of professional workers in medicine and associated sciences will find herein a fund of interesting information which may prepare them to appreciate more clearly the possibilities and limitations under which the officers of Federal, State or Municipal health organizations must apply the accepted facts of science in the administration of the public health laws on behalf of the community.

Beginning with an historical sketch of the disease and proceeding with the record of the epidemic in this City, with a reference to the extent of its spread elsewhere in the United States, the report will deal with every phase of the disease as seen by the Department of Health, in co-operation with other Departments of City, State and Federal Government, and with many official and unofficial advisory groups and organizations.

No such report can be the production of one mind, and I wish here and now to express with all sincerity my respect and admiration for the universal co-operation of the many loyal public servants in the Department of Health who have made this publication possible.

At this time and place, it is peculiarly fitting to express and record the appreciation felt by the Board of Health for the admirable skill and spirit shown by the officers of the United States Public Health Service, who were assigned to undertake epidemiological studies of the disease in

and about New York City, and to assist in such phases of the administrative supervision of the disease as affected interstate quarantine.

The Department of Health of the City received many benefits from the cordial and effective co-operation which the State Department of Health took pains to offer and exhibit on all suitable occasions, and there were instances where the officers of the City were able to reciprocate in kind for the benefit of the citizens of State and City, whose interests would often have been jeopardized if there had been anything less than sympathetic action by the respective departments.

Respectfully submitted by

HAVEN EMERSON, M. D.,
Commissioner of Health.

CHAPTER I.

Historical.

Poliomyelitis has been recorded in the United States as among the rarer diseases of the central nervous system since it was first described by Heine in 1840. In 1874 it was a disease of such rare occurrence or so seldom recognized as a distinct clinical entity, that the leading consulting physicians of the largest cities in this country and abroad had not, in their whole professional careers, seen more than a handful of cases. The knowledge of the pathology of the disease at that time was based on a smaller number of autopsies recorded in the whole medical literature than were performed at one of the Department hospitals during the past summer. The average number of deaths from poliomyelitis in any one of ten weeks during July, August and September, 1916, exceeded the deaths from this disease reported in the past five years in New York City. In fact, the deaths from this disease were of such rare occurrence up to the year 1912, except during the epidemic of 1907, that they were not even separated from the general group of "other diseases of the nervous system." In the years 1912-1915 there were respectively 70, 54, 34 and 13 deaths from the disease and in 1916 up to June 1, there were only 6 deaths, while the average weekly number of deaths from July 1 to September 9, 1916, was 209.

Since the early years of this century there has been an increasing general area of distribution in this country and a growing incidence of the disease. Over 5,000 deaths from poliomyelitis are recorded by the United States Census Bureau, as having occurred in the registration area* in the quinquenium 1910 to 1914. A conservative estimate would place the probable number of cases during these five years in this area as 30,000.

Over 27,000 cases and 6,000 deaths from poliomyelitis occurred in the registration area from June to November, 1916. During the past summer there were other distinct foci of infection evidently independent in their origin and not, so far as could be learned, traceable to each other or to the City of New York. These were roughly the State of Minnesota and the South Atlantic States, each of which areas was responsible for a considerable number of cases pretty widely distributed.

Although foci of infection in many localities in the States adjacent to New York City and State, closely bound to it by social, business and transportation connections, apparently had their own local origins, the great majority of cases in the metropolitan area extending into New Jersey, Con-

*The Registration Area of the U. S. Census embraces those states and cities whose vital statistics are regarded as sufficiently complete and accurate to warrant tabulation by the Census Office. At the present time the area includes 26 states and 36 cities outside of these states. In 1916 this area had a population of 71,621,632.

necticut, Massachusetts and New York State should be considered as units in the New York City epidemic. As has been observed to be the case in epidemics elsewhere, the distribution of cases outside of New York City into the adjacent country and cities followed closely the traffic lines and the distribution of cases or carriers of the disease from this City.

Thus it can be seen that, apart from the intense local interest and alarm resulting from the sudden attack of the disease in New York City in epidemic form, there is a national and even continental aspect to the recent events which justifies prompt and complete reports of all available facts, and demands the closest study and attention of the federal state and local health officers throughout the country.

Since 1912, when there was a pretty even distribution of the disease throughout the year by months, with a total of 504 cases, there had been a steady decrease in its incidence until June, 1916, as can be seen from the following table:

	1911.	1912.	1913.	1914.	1915.
January	6	31	12	13	7
February	5	53	5	11	3
March	3	38	6	8	4
April	3	23	7	7	4
May	3	14	11	2	4
June	3	40	7	7	7
July	21	42	38	4	4
August	27	40	44	21	11
September	58	61	95	26	11
October	89	75	48	18	26
November	67	65	23	6	16
December	73	22	4	6	3
Total	358	504	300	129	100

The reporting of the disease by physicians was not required in New York until November, 1910, and estimates of its previous prevalence based on deaths are unreliable, owing to wide variations in the reported death rate in different epidemics. Moreover, there is reason to believe that the number of reported cases shown in the above table is considerably below the number which actually occurred. This is borne out, for example, by observations made at some of the larger dispensaries, of the number of old paralytic cases applying for treatment.

In the first five months of 1916, only 17 cases of the disease were reported, of which 8 were in Manhattan, 4 in The Bronx, 5 in Brooklyn and none in Queens or Richmond.

Epidemic of 1916.

To judge by the reports of physicians up to June 1st, there was nothing to excite suspicion that we were already at the onset of an epidemic. Within the first eight days of June, 6 cases were reported from Brooklyn,

from which borough no cases had been reported up to this time in 1916 and none in June from the other boroughs. The six cases were reported as follows:

Date Reported.	Name.	Age.	Address.
June 6th.	John Pamaris.....	10 months	53 Garfield place.
June 6th.	Armanda Schuccjio	2 years 8 months	5014 Seventh avenue.
June 8th.	William Cortell	8 years	630 Forty-fifth street.
June 8th.	John Lessa	20 months	282 First street.
June 8th.	Tony Piclo	1 year	251 Third avenue.
June 8th.	Mitchell Alvin	1½ years.....	78 Utica avenue.

Only five cases in the entire city had been reported to the Department of Health in May, and yet when we assign the cases, which were reported at later dates (discovered by the house to house visits of doctors and nurses of the Department in the section of Brooklyn first invaded, a thickly populated Italian section, bounded by Fourth avenue, Nevins, Carroll and Union streets), to the date when the first symptoms of sickness were observed, i. e., to the date of onset of the disease in each case, we find that in the month of May, 29 cases of poliomyelitis had their origin and were doubtless capable of spreading the disease to or through those with whom they came in contact.

It must be remembered that none of these 29 cases, in which the onset occurred before June 6th were known to the officers of the Health Department, until the house to house search, after June 6th disclosed their whereabouts, and it was only the report of the 6 cases from Brooklyn, 2 on June 6th and 4 on June 8th, which served as a warning of an impending epidemic.

Further, it is well to bear in mind that although at the beginning, and throughout the epidemic, Brooklyn supplied the largest number of cases, the unreported cases which had their onset before June 6th were distributed throughout the five boroughs:

3 in May in Manhattan.
1 on June 2d in The Bronx.
22 in May in Brooklyn.
3 in May in Queens.
1 in May in Richmond.

On June 8th, when the homes of the 6 reported cases were found to be in a fairly circumscribed area, and when a notice was received from the research force of the Department laboratory that an unusual number of requests had, within the past few days been received, for positive diagnosis in cases of suspected poliomyelitis, orders were given to make an immediate and special investigation, by inquiry of physicians practicing in the area affected, and by instituting a house to house canvass for unreported and unrecognized cases. That there was not an earlier recognition of the approaching epidemic and a study of the disease from the epidemiological

standpoint, was due solely to the fact that none of the cases which occurred in May and before the 6th of June were reported to the Department of Health. It is not to be inferred that this failure was due wholly to the not uncommon delay in reporting cases of notifiable disease by practicing physicians, but is to be attributed largely to the fact that this disease is not always sufficiently severe in its early symptoms to demand immediate medical attention, according to the idea of many parents, and further to the equally important fact that only a complete physical examination with special attention to the response of various tests of muscular reflexes will elicit the evidences of paralysis in many of the mild cases.

Only a thoroughly alert public and a forewarned profession could have prevented the delay in official knowledge of the threatening epidemic. That energetic measures were taken as soon as six verified cases of the disease were reported on June 6th and 8th, is a sufficient reply to any lingering suspicions that the Department of Health awaited the actual presence of a calamity before taking measures of protection.

On June 15th, in addition to a number of cases discovered by visits of medical inspectors and nurses throughout the now obviously infected area of Brooklyn, several cases of recent paralysis were noted among the infants attending the Baby Health Station at 184 Fourth avenue, Brooklyn. The mothers of these children, all unaware of the existence of the disease or its communicable character, brought their babies to the doctors, complaining that the child could not hold the bottle or that the leg seemed limp for the past few days, and there had been a little loss of appetite and some restlessness.

Official Notice of Unusual Prevalence of Acute Poliomyelitis in Epidemic Form.

The first official announcement of the existence of an unusual number of cases of poliomyelitis in New York City (in the Borough of Brooklyn) was made in a press bulletin issued Saturday, June 17th, and published in the newspapers on the following day. As in the case of all the press bulletins issued by the Department of Health, multigraphied copies of this bulletin were sent to all the newspapers in the City, to the medical journals and to all the important news bureaus. This first bulletin called attention to the value of spinal fluid examinations in the diagnosis of poliomyelitis and announced that lumbar puncture and the laboratory examination of spinal fluid would be made free of charge by the Department of Health.

At the same time a letter was sent to all the physicians in Brooklyn, calling attention to the existence of a group of cases of poliomyelitis in their borough, and asking for their co-operation in controlling the disease.

Owing to the interest manifested by the newspapers in the epidemic, and in order to make certain that information emanating from the Depart-

ment of Health should be accurate, a daily press bulletin service was inaugurated.

At a little later date (June 30th), the Surgeon General of the United States Public Health Service was notified that an epidemic was under way, and the facts upon which this belief was based were given in full. The New York State Department of Health and the health officers of neighboring States, and of a few of the larger nearby communities were notified at the same time.

Emergency Field Force Assigned.

On June 20th, seven additional nurses, and on June 22nd a supplementary corps of medical inspectors were assigned, the nurses to search for unreported and unrecognized cases by an extension of the house-to-house visits, and the medical inspectors to visit the numerous cases now reported, to confirm the diagnosis made by the family physician and to examine suspects reported through many non-professional channels.

The American Society for the Prevention of Cruelty to Animals was requested to take immediate measures to collect all stray cats and dogs found in the infected localities.

The Department of Street Cleaning began active co-operation to give a special clean-up in South Brooklyn and to discontinue the use of burlap bags in the daily collection of rubbish.

On June 23rd, there were reported 48 cases, about half among Italian families, as compared with a total of 63 reported up to this date. Many of these were of considerable duration, their onsets having occurred even in the month of May, and almost all of them had either escaped recognition as poliomyelitis by the private physician or had not been under medical care. A further evidence that many cases had escaped detection for some weeks, and had been exposing others to infection for a considerable period, was presented by a leading orthopaedic surgeon in Brooklyn, to whose dispensary class cases applied with already well developed deformities, following the acute onset of paralysis.

On June 24th, in order to give immediate reply to many anxious inquiries and suggestions as to the part played by schools in the spread of the disease, a press bulletin was issued, pointing out the facts that 90 per cent. of the cases were in children under school age, that the cases were not limited to any one school district or to children of the same classroom. The school term ended on June 30th. At the same time there was issued a special bulletin for parents, emphasizing the known facts which would be of service in preventing the spread of the disease in homes. The presence of the virus in the discharges from nose and throat, and bowels of infected individuals, the probability that atypical and non-paralytic cases were as dangerous and as numerous as the paralytic cases, and that little value or protection could be expected from the use of so-called antiseptic gargles and nose-sprays, were explained.

Co-operation of Newspapers.

The advantages to be expected from intelligent and alert self-interest, and the rapidly increasing number of cases reported day by day, determined the Department to take the unusual step of publishing in the daily press the names and addresses of all true cases reported in the previous twenty-four hours. This decision was made after conference with the Corporation Counsel's office and with the managing editors of some of the prominent newspapers. The first list was printed on June 28th, and this practice was followed daily thereafter until September 9th, after which date the Sunday list was omitted each week. On October 17th a weekly list was substituted, and on November 6th further press publication of names and addresses was discontinued, and thereafter the reported cases of poliomyelitis were printed only on the daily list as issued for many years past to all schools, child caring institutions, etc. From the beginning, the interest and co-operation of foreign-language newspapers were enlisted for publication of daily lists, and all official press bulletins.

Establishment of Quarantine Regulations.

On June 28th the Board of Health met and passed resolutions requiring eight weeks' isolation instead of six weeks, and demanding immediate hospitalization of all patients for whom the following requirements could not be met:

(*a*) Daily attendance of a physician.
(*b*) Special attendant who must observe quarantine regulations, do no cooking, and avoid contact with other children of the household.
(*c*) Special room for patient and attendant.
(*d*) Screening of windows of patient's room.
(*e*) Separate toilet for the family.
(*f*) Exclusion of food handlers from work.
(*g*) Disinfection of bed linen of the patient and renovation of room occupied, after removal of patient.

The rapid accumulation of patients at Kingston Avenue Hospital, to which all Brooklyn cases were taken, made it necessary to transfer convalescents to other hospitals of the Department, and later to the many private hospitals which offered their facilities to the City. This procedure of sending all cases for immediate admission to a hospital in the borough of residence was carried out, with but rare exception, throughout the epidemic, the opening of the new contagious disease hospital of the Department of Health, the Queensboro Hospital at Jamaica, on June 29th, and the offer of the Swinburne Island Hospital and medical and nursing staff to the City by the Health Officer of the Port, providing Queens and Richmond with excellent local isolation facilities, the Boroughs of Manhattan and The Bronx being served by Willard Parker and Riverside Hospitals respec-

tively. Patrolmen of the Sanitary Squad were assigned to visit quarantined premises every other day and enforce the regulations.

On June 29th the Queensboro Hospital was opened, thus giving immediate relief to the Kingston Avenue Hospital, already crowded. By using the screened porches and obtaining accommodations for nurses in a neighboring house rented for this purpose, it was found possible to accommodate as many as 112 children at a time, though the normal capacity of the hospital is 80 patients.

Advisory Committee on Poliomyelitis.

On June 30th, there met for the first of its nine sessions, an Advisory Committee to the Department of Health. To this Committee were submitted all the important matters in relation to the administrative and professional work of the Department of Health in the epidemic, concerning which professional opinion was divided, or at least not yet positively declared. Two members of the Committee on Poliomyelitis of the New York Neurological and the Pediatric Section of the New York Academy of Medicine, which studied the epidemic of 1907, and prominent consultants in three special branches of medicine, namely pediatrics, orthopaedics, and neurology, served on this Committee throughout the summer, and all the decisions reached, or new policies introduced by the Department of Health were submitted to this Committee for discussion and vote. Furthermore, through this Committee, the Department was able to keep in touch with the needs and difficulties of the medical profession and to meet as promptly as possible all reasonable complaints, for it must be evident to the lay reader that the administrative regulation of the disease implied not only interference with the personal liberty of the members of many households, but a sacrifice of important professional opportunities and income by the physicians to the poor, whose poliomyelitis patients were removed from insufficiently equipped homes to the hospitals.

Immediately after the meeting for organization of the Committee, at which the hospitalization and quarantine period already adopted by the Department of Health was endorsed, two leaflets of information were issued, one for laymen and one for physicians, and posters and leaflets in Italian and Yiddish were prepared. The Committee advised the placarding of premises for poliomyelitis, a practice previously confined to smallpox, scarlet fever, diphtheria and measles.

Increase in Field Force—Educational Campaign Started.

On July 1st, ten additional inspectors (physicians) and ten more nurses were assigned to the special corps of field agents to discover cases and maintain the observance of home quarantine regulations. On this date also was held the first lecture on poliomyelitis for the benefit of the practicing physicians of Brooklyn. Dr. Simon Flexner assisted the representative of the

Department of Health in presenting to the physicians assembled at the Polhemus Clinic of the Long Island College Hospital the important facts bearing upon the diagnosis, transmission and prevention of the disease. Addresses and lectures, and lecture-clinics were given all through the epidemic, those which were of special importance being the great meeting of the New York Academy of Medicine on July 13th, when the Aeolian Hall was filled to its capacity to listen to a symposium upon various phases of the disease, and the system of clinics at hospitals inaugurated on July 24th.

Special Poliomyelitis Clinics.

Inasmuch as prompt diagnosis by the attending physicians is of paramount importance in the administrative control of infectious diseases, and because it was realized that many of the physicians in this city probably had not had the opportunity to observe any considerable number of cases of poliomyelitis in the past, the Department of Health decided to organize a series of bedside clinics open to practicing physicians in this city. Through the co-operation of the attending physicians, special poliomyelitis clinics were arranged for at the following hospitals, the clinics to be held during the week commencing July 24th:

Babies' Hospital,
Bellevue Hospital,
Kingston Avenue Hospital,
Mt. Sinai Hospital,
Swinburne Island (Quarantine Station),
Willard Parker Hospital.

Multigraphed announcements regarding these clinics were sent by mail to every physician in the city, and a notice was also published in the Weekly Bulletin. The clinics were so well attended and so many requests were received for more clinics that an additional course was arranged for, beginning August 14th. Held at the following hospitals, these clinics continued until about October 1.

Babies' Hospital, every Thursday at 4 P. M.
Bellevue Hospital, Ward 32 (Contagious), every Monday at 4 P. M.
Kingston Avenue Hospital, every Friday at 4 P. M.
Lebanon Hospital, every Tuesday at 3:30 P. M.
Mt. Sinai Hospital, every Friday at 4 P. M.
Willard Parker Hospital, every Wednesday at 4 P. M.

In order that the clinics would give the physicians attending the same a fairly complete summary of the known facts regarding poliomyelitis, the following outline on the points to be covered was sent to each physician holding a clinic:

NOTES ON POINTS TO BE COVERED IN A LECTURE-CLINIC ON POLIOMYELITIS.

The Disease in General.

1. Nature of the Disease (emphasize general systematic intoxication).
2. Where virus is found (mucous membrane of nose, throat, intestines, central nervous system, lymph nodes).
3. How virus is spread (nose and throat—intestinal) personal contact.
4. Epidemiology (emphasize importance of non-paralyzed cases and normal "carriers").

The Case or Cases in Particular; to be demonstrated.

1. History of case.
2. General systematic intoxication.
   a. Psychic state:
      (1) Stuporous.
      (2) Hyperexcitable.
      (3) Alert and apprehensive.
   b. Physical signs:
      (1) Fever, pulse and respiration increased.
      (2) Lymphadenopathy.
      (3) Tenderness.
3. Central Nervous System:
   a. Reflexes.
   b. Detection of weak muscle groups.
   c. Ataxia and equilibrium disturbances.
   d. Spinal region pain sign. Protective Opisthotonos:
      (1) Neck.
      (2) Kernig.
4. Laboratory Aids:
   a. Blood count.
   b. Spinal fluid.
   c. Autopsies.
   d. Animal inoculation.
5. Treatment:
   a. General Management:
      (1) Rest.
      (2) Diet.
      (3) Pain control.
   b. Nursing:
      (1) Gaining confidence.
      (2) Careful manipulation.
      (3) Asepsis.
   c. Special Procedures:
      (1) Immune serum in injection.
      (2) Adrenalin.
      (3) Artificial respiration, etc.
      (4) Massage and passive motion.
      (5) Splinting, etc.

The City and the medical profession owe a special debt to the volunteers who, amid the anxious hours overfilled with hospital duties and private practice, afforded the necessary time and thought to offer to their fellow practitioners admirable clinical instruction, under the most auspicious conditions, for direct application among the children of the City.

ADDITIONAL PRIVATE AMBULANCES ASSIGNED TO THE SERVICE OF THE CITY.

On July 2nd it was found that the Department ambulances were insufficient to remove all cases of isolation hospitals as rapidly as they were reported and the diagnosis was confirmed. Delays of serious nature occurred and as promptness of separation of the sick from the susceptible was the essence of the plan now in operation, the Ambulance Board was requested to loan additional ambulances, which they did. Throughout the epidemic the Department of Health had at its service besides its own nine ambulances, those loaned by twenty-three other hospitals, and made available for periods of one to twenty-four days at a time. This generous and timely aid was of a kind with many other similar instances of public spirit shown by the hospitals of the City throughout the summer.

In addition to this a prominent automobile concern donated the services of a special motor ambulance throughout the epidemic.

On this day also, the superintendents of dispensaries and institutions for children were warned to hold any suspected or recognized cases of poliomyelitis on the premises until the arrival of a Department representative.

By this time it was evident that, even by sacrificing some of the many important routine duties of the Health Department and devoting the entire staff of the Department to the control of the epidemic, the necessary means of coping with the situation would be lacking, and at a special meeting of the Board of Health, the following memorial was prepared, requesting the Mayor to use his powers under the Charter, to make available funds to meet the extraordinary expense of the Department:

> "Whereas, The Board of Health having taken and filed among its records what it regards as sufficient proof to authorize the declaration of great and imminent peril to the public health by reason of impending pestilence arising from an outbreak of poliomyelitis (infantile paralysis) throughout the City, pursuant to section 1178 of the Greater New York Charter, the Board of Health hereby
>
> "Resolves, That great and imminent peril exists to the public health of the people of the City of New York by reason of an outbreak of poliomyelitis (infantile paralysis) throughout the City of New York; and further be it
>
> "Resolved, That the Board of Health does hereby order that every effort be made to check and stamp out the outbreak of poliomyelitis (infantile paralysis) and does order that the same be done by and through its officers and employees and those whom it may employ for such purpose, and does hereby cause such expendi-

tures to be made (beyond those duly estimated for and provided), for the preservation of the public health as may be necessary and as public safety and health may demand. The expenditures aforesaid are hereby consented to.

"HAVEN EMERSON,
"Commissioner and President, Board of Health,

"FRANK A. LORD,
"Second Deputy Police Commissioner.

"L. E. COFER,
"Health Officer of the Port of New York,

"July 5, 1916.

"On the foregoing resolution,

"I, JOHN PURROY MITCHEL, Mayor of The City of New York, do hereby declare that imminent peril to the public health exists and approve of the foregoing expenditures.

"JOHN PURROY MITCHEL,
"Mayor.

"July 5, 1916."

The report of the Auditor of the Department will give, at a glance, the character of the personal services and supplies found necessary and met from the emergency fund (page 72).

PUBLIC ASSEMBLAGES RESTRICTED TO ADULTS.

On July 5th all theatres and moving picture theatres were closed to children under sixteen, and on July 8th, the streets known as play blocks, provided for the sake of giving safe play space for the children in many parts of town under the auspices of the Police Department were abandoned. Street carnivals, parades, public picnics and excursions were forbidden. These restrictions were removed from theatres, except for children under 12, on September 9th, and on September 25th restrictions of all kinds applying to places of public assembly were removed.

RESTRICTIONS ENFORCED IN INSTITUTIONS FOR CHILDREN.

On this date also, in order to prevent the introduction of poliomyelitis into the institutions for children, the following precautions were put into effect:

1. Repeated sanitary inspections made of premises and recommendations offered in regard to proper cleaning of buildings.
2. All windows and doors of children's dormitories and dining rooms were screened.
3. An effort was made to kill all flies and vermin, such as bedbugs and roaches.
4. Garbage and refuse were immediately destroyed on the grounds.
5. The milk supply and other food used were examined at frequent intervals, and any evidence of deterioration was immediately

called to the attention of the persons in charge. Light, easily digested food advised.

6. The daily brushing of the teeth and washing the mouth with some form of mild antiseptic solution was encouraged.

7. Individual towels and soap were given to each child.

8. The children were bathed frequently and the clothing was kept scrupulously clean. Each child was given a clean piece of white muslin every day to be used as a handkerchief.

9. An examination by the nurse was made of each child every morning, and whenever any fever was found the institution physician was immediately called and he in turn notified the institution inspector of the Health Department, if necessary. If any evidence of a contagious disease was discovered, the child was immediately placed in quarantine. No child was allowed to remain in the dormitory if sick.

At the beginning of the epidemic of poliomyelitis, the Department of Charities and the various Children's Courts of the City were communicated with and were requested to notify the Health Department when a child was committed to an institution. A daily report was received, giving the name of the child, address whence it came and the name of the institution to which it was committed. The child was examined by an inspector of the Department of Health on the day after it was assigned to the institution and again after the expiration of the two weeks' quarantine, before being allowed to go to the dormitory of the institution proper.

REGULATIONS OBSERVED BY THE INSTITUTIONS, AT THE DIRECTION OF THE DEPARTMENT OF HEALTH.

1. Every child must be examined by an inspector of the Division of Institution Inspection on the day following its arrival at the institution and again after the expiration of two weeks, before being admitted to contact with the other inmates.

2. Visiting children by parents, guardians or relatives is temporarily prohibited.

3. Food, articles of clothing or toys must not be brought to the children by parents or friends during the present epidemic of poliomyelitis.

4. Permission to children must not be given to visit relatives or friends in the city and return to the institution.

5. Children must not be permitted to attend public gatherings.

6. Unnecessary grouping of the children of one dormitory with those of another is to be avoided.

7. Every child showing evidence of being ill must be removed immediately to the institution hospital and not be allowed to remain in the dormitory. If the physician suspects any contagious disease, he is to notify the Health Department at once, and an inspector trained in the diagnosis of infectious diseases, will be sent to examine the patient.

8. Employees living outside of the institution must change their clothing before mingling with the children.

9. Every child going to an institution from its residence in the city for a temporary stay, must have a certificate from a physician

(and a certificate from the Health Department showing that no cases of poliomyelitis have been reported at the address given) before being admitted to contact with the other children. An inspector of the Health Department must also examine the child on the day of its admission to the institution, and again before allowing it to return home.

On July 5th, specific instructions were issued to the inspectors and nurses in charge of the 59 Baby Health Stations and these were further supplemented on July 10th.

1. All known or suspected cases of anterior poliomyelitis coming to your attention, are to be reported to this office on the white filing card, giving the name, age, address, floor, duration of illness, and name and address of physician in attendance.

Prior to this written communication, please telephone to the clerk-in-charge of the Division of School Medical Inspection, the above particulars, and note on the filing card above mentioned, the fact of such telephonic communication.

2. In cases where anterior poliomyelitis exists in the family, the babies may be enrolled, but they must not be allowed to visit the station.

The mother or other member of the family may secure milk at the station, and if advice and instruction are necessary, the inspector or nurse should visit the home.

This situation is to be treated as are other contagious diseases, at present.

3. Babies living in houses in which anterior poliomyelitis exists but not in the same family, may be enrolled in the regular manner.

During this epidemic all the nurses and inspectors should impress the mothers with the necessity of absolute personal and home cleanliness, with the danger of allowing refuse to remain around the house, with the importance of covering garbage cans, the necessity of keeping children away from others as much as possible; the dangers of coughing, sneezing and expectoration; the danger of flies as transmitters of the disease; the importance of nasal hygiene; the advisability of securing immediate medical care when the child is taken ill, especially with fever, vomiting, drowsiness or weakness of the extremities, and of isolating such a child from the rest of the family.

Impress, furthermore, upon the parents, the importance of quarantine, in true cases, and ask them to report to you any suspicious cases which come to their attention.

Each and every one should feel her personal responsibility in the effort which is being made to control an epidemic which threatens to assume large proportions.

All contemplated outings of mothers and babies must be cancelled.

(July 10th)

1. Look over the daily list of contagious diseases immediately upon your arrival at the station each morning, and note the name and address of all cases of anterior poliomyelitis listed in your station district.

2. Record on a large sheet, in alphabetical or street order, the name and address of every case of anterior poliomyelitis recorded on

the lists since June 1, 1916, and continue this daily until further notice, adding such names as appear on the daily contagious disease lists.

3. Arrange to have mothers or other members of families in which a case of anterior poliomyelitis exists, and who visit the station for the purpose of obtaining milk, call for the milk either early in the morning or at the close of the morning. See to it that the milk is given to them at once, and that they leave the station immediately. Under no circumstances must persons living in infected premises, who come for milk, be permitted to mingle unduly with the regular clientele.

4. Enrolled babies from infected houses, but not from infected families, must be instructed and treated, and given preference over others in attendance at the station, and thus disposed of as quickly as possible.

5. All employees—inspectors, nurses, nurses' assistants—must report immediately by telephone to the clerk-in-charge of the Division of School Medical Inspection the name, address, floor, duration of illness, and name of physician in attendance, if any, of all non-placarded true or suspicious cases of poliomyelitis coming to their attention. This clerk will telephone report of case to the Bureau of Preventable Diseases. If corroboration of diagnosis is necessary, the inspector or supervisor should visit the home. This telephonic communication must be followed by a full statement of the above particulars on a white filing card, and forwarded to the Central Office, Division of Baby Welfare.

6. All employees, when making home visits, must instruct and advise the public in preventive measures, as outlined in the instructions under date of July 5, 1916.

7. Should any child ill with anterior poliomyelitis visit the station, he or she must be excluded at once, the particulars of the case telephoned immediately as above outlined, and the mother instructed to take the child home and isolate it from other members of the family.

United States Public Health Service Assigns Special Corps of Investigators.

On July 6th, the Secretary of the Treasury in person offered to the Mayor the assistance and co-operation of the United States Public Health Service. The offer, which was gratefully accepted, resulted in the assignment of eleven officers, one epidemiologist, and one biologist to the work in and about New York City. By conference between the officers in charge and the Department of Health, it was agreed that the Public Health Service should undertake certain field and statistical studies of the disease for which the Department of Health was not at that time equipped and for which the personnel of the Public Health Service was exceptionally well qualified.

Laboratory studies were found impracticable for various reasons and this phase of the investigation by the Public Health Service was carried on at the Hygienic Laboratory at Washington, D. C., with material sent from New York City. It would be inappropriate to include in the report of the

Department of Health of New York City the results of these admirable studies which will appear in the official reports of the Public Health Service. We have been allowed, however, to publish as part of this report the statistical tables prepared by these collaborators.

STATEMENT BY THE MAYOR.

On July 9th the Mayor called a conference of his commissioners to consider in what ways the entire force of the City Government might be used for protection of the public. The departments particularly concerned, in addition to the Health Department, were the Police Department, Tenement House Department, Department of Street Cleaning and Department of Water Supply, Gas and Electricity.

The following statement was issued in the press the next morning and did much to quiet the growing public alarm, and give confidence that no effort would be spared:

"*All Resources of the City Mobilized in Fight Against Paralysis.*

"Although very little is known of the origin or transmission of infantile paralysis, I am advised by the health authorities that all scientific experience points to the fact that it is communicated by direct personal contact, and that the germs do not live apart from the human body; in other words, that it is necessary for a diseased person, or one who has been in contact with a diseased person to come in turn into contact with a susceptible individual in order that the disease be communicated.

"Cases Segregated. The Health Department is now bending every energy night and day to prevent the spread of the infection through such contacts as just described. This it is doing by segregating the cases in hospitals, as rapidly as the diagnosis can be positively made, and by educating the people in the method of preventing personal contact by personal cleanliness.

"At the same time, we have called into co-operation the national health services to aid in tracing the origin of this epidemic, and in determining more accurately than our present knowledge permits, the method of transmitting the disease.

"In the meantime, and whatever the method of transmission may be, I have determined that every precautionary measure in the nature of clearing out refuse from halls, areas, yards and cellars, its collection and immediate removal from the streets shall be taken in so far as the city government has the power to enforce the action.

"Accumulations of refuse containing garbage in the public streets at various points in the congested districts have been reported during the last few days. These are conditions that exist continuously in the congested districts and are solely the product of violations of city ordinances by householders, who, despite repeated warnings and all that we can do to the contrary, insist on throwing the refuse into the streets in place of collecting it in proper receptacles as provided by law. A real city clean-up, with the maintenance of cleanly conditions, can be effected only if householders will co-op-

erate by observing these ordinances forbidding the spreading of refuse in the streets.

" Receptacles for Garbage. I wish to make it perfectly clear that the Street Cleaning Department is not responsible for the refuse which can be found any morning lying in the streets of the congested districts, and that it discharges its duty by removing that refuse as soon as the carts and men of the department reach these streets in the course of their regular day's work.

" Householders are also required by law to maintain watertight and properly covered metal receptacles for garbage, and to deposit rubbish securely tied in bundles so that it will not spread over the streets.

" I have directed the Police Department to enforce rigidly these ordinances. I have specifically directed that any householder, storekeeper or other person found depositing garbage or rubbish in the streets in violation of these ordinances is to be arrested and arraigned before a Magistrate. I am requesting the Chief City Magistrate to urge all Magistrates in the city to co-operate with the city authorities in enforcing the law, and to impress its importance upon violators by adequate penalties.

" I have further directed the Tenement House Commissioner to utilize all the resources of his department to compel the cleaning up of halls, areaways, cellars and yards throughout the city.

" I have directed the Street Cleaning Commissioner to accelerate to the limit of possibility the collection of garbage, ashes and refuse properly deposited in receptacles and to continue to clean from the streets such refuse as may be thrown there in violation of law. This is done by the Street Cleaning Department every day at the present time, but we propose to attempt to complete the work somewhat earlier each day than at present.

" More Water for Streets. There is no more important feature of the work of the Department of Street Cleaning at the present time than that of street flushing. This is a very useful way of using water, provided it be not wasted. Every possible effort is made to supervise the individual street cleaners so that they shall not use the hose longer than necessary on any one spot, though it is unfortunately often difficult to control their individual operations. In due course it is hoped to rectify this condition. Meanwhile it should be remembered that not over one per cent. of the total amount of water consumed daily is used for street cleaning, while elsewhere amongst private consumers there is a preventable waste of from ten per cent. to fifteen per cent. of such total.

" The Department of Water Supply has been co-operating with the Department of Street Cleaning in this matter throughout the present administration. I have directed its further co-operation in the present situation in order that still more water may be available to the Street Cleaning Department, to the end that the streets including sidewalks particularly in congested districts shall be thoroughly washed down each day.

" The Street Cleaning Department will increase its night work in Manhattan, so that every street will be cleaned every night. In Brooklyn where the epidemic has been most severe, a number of hose gangs employed in night flushing will be increased from 15 to

40 in the infected area. Night work will be increased by 50 per cent. To do this the Street Cleaning Department must reduce its force employed in the daytime and unless property owners will co-operate by avoiding the present general widespread violation of ordinances in the matter of littering the streets with refuse, there undoubtedly will be an increase in the unsightly appearance of streets during the daytime. Here I expect particularly the co-operation of the Police Department through the rigorous enforcement of the ordinances.

"In short, it will be the effort of the city government during the continuance of the epidemic of infantile paralysis to focus all its forces on a general clean-up as a means of reducing the possibility of the spread of the disease. Resources of the Health Department, Street Cleaning Department, Police Department and the Department of Water Supply and the Tenement House Department will all be employed to this end.

"There is no occasion for alarm or panic. The careful observance of the simple directions given by the Health Department as to personal and household cleanliness will go far to prevent further spread of or exposure to infection.

"I wish to urge citizens to permit the removal of their sick children to hospitals selected by the Department of Health. The death rate in this epidemic has been appreciably lower in hospitals to which patients are taken for the sake of isolation than in patients' homes where adequate care cannot be provided."

The result of effective co-operation was soon evident, and, according to the critical opinion of the inspectors of city departments and of careful and observant citizens, the highways and premises of the city were never in so clean and wholesome a condition as everywhere prevailed through the remainder of the summer.

Private Hospitals Co-operate.

On July 10th it became quite apparent that with at least four weeks more of increase in the number of cases to be expected, and a daily report of about 100 cases, the capacity of the hospitals of the Department of Health would soon be reached and either additional hospital beds must be obtained, or the policy of hospitalizing the cases must be abandoned. The hospitals of the city were appealed to by the Mayor, and within a week enough beds had been promised to accommodate the expected census of patients.

Separate wards were in most cases made available and conducted according to established practice for the care of communicable diseases. In two notable instances, complete hospital establishments were put at the disposal of the Department of Health. The Health Officer of the Port offered the use, for patients from the Borough of Richmond, of the isolation hospital at Swinburne Island, with a capacity of 75 patients. With certain supplies and personal service contributed by the Department of Health, the wards were immediately made available, and throughout the remainder of the epidemic the necessity of transferring more than a small number of

cases from Staten Island to Department hospitals, in other Boroughs, was avoided. The New York Hospital, having its children's wards filled to capacity, but wishing to make its contribution to the service of the City, offered to occupy and maintain a hospital with one hundred and six beds in the building recently vacated by the New York Orthopaedic Hospital, in East 59th street. The use of the building was given to the New York Hospital, through the Department of Health, by the Orthopaedic Hospital, and the New York Hospital promptly installed the necessary staff and equipment, even to the point of establishing a pathological laboratory for research purposes at the hospital.

The public spirit and resourcefulness shown by the 28 hospitals, which put at the disposal of the Department of Health a total of 726 beds, cannot be too highly praised. By their co-operation they played an important part in the method of sanitary control of the disease which had been undertaken by the Health Department. Bellevue Hospital and the hospitals of the Department of Charities provided a maximum of 660 beds.

No attendant, physician, nurse or domestic, and no patient admitted to any of the hospitals throughout the city, for other cause than poliomyelitis, during the epidemic, contracted poliomyelitis. This has been the almost universal experience in the past, and has often been brought forward as a proof of the non-communicable character of the disease. In the minds of those who have studied the disease in the field, this experience would rather indicate that the simple methods of ward cleanliness and the usual technique of personal care employed in hospitals suffices to prevent communication of the disease, and this opinion is borne out by the experience in institutions for children where similar simple measures prevented the spread of the disease. One of the field nurses of the Department engaged in daily house to house visits among the families where active cases were isolated developed poliomyelitis in a severe paralytic form.

The City paid at established rates for the care of patients admitted to the hospitals above mentioned. A complete statistical record of the services of these hospitals is to be found on pages 261, 262, and 263.

Conference of Physicians Called by the Mayor.

On July 12th the Mayor requested the opinion of members of the Advisory Medical Board of the Board of Health, and of a number of other prominent scientists and sanitarians as to further means of checking the spread of the epidemic. A sub-committee was appointed, which met the following day, and decided that no further administrative or educational measures could be expected to produce any beneficial results, but reported that it would be advisable to take such steps as might prove practicable to discover, trace and keep under observation persons who might have been in immediate contact with those sick with the disease. In other words, the sub-committee advised the Mayor that some additional knowledge might be

expected from an intensive study of the contacts and secondary cases occurring throughout the city. Inasmuch as this was in the nature of experimental field work, which the Department of Health was not at the time free to undertake, the Mayor accepted the offer of the Rockefeller Foundation to defray the cost of the proposed investigation. The entire personnel of the field and office force, together with the director, was put upon the payroll of the Department of Health, and the funds provided by the Rockefeller Foundation were disbursed through the Department of Health on vouchers signed by the Director, the Vice-Chairman of the committee in charge (the Mayor, Dr. Simon Flexner, Vice-Chairman, Dr. Haven Emerson, Dr. W. B. James and Dr. G. R. Butler) and by the Commissioner of Health. The work was undertaken soon after and a report of the results will be found on page 111.

On July 13th the special poliomyelitis field corps of the Department was further increased by 40 medical inspectors and 10 nurses.

Travellers' Certificates.

On July 14th there was undertaken for the first time a new procedure which developed into such large proportions and caused so much public comment, chiefly of adverse character, that it deserves special mention. Owing to the local restrictions adopted by various health boards in many adjacent states and communities, within easy travelling distance by rail, boat, or motor, from New York, which were in the nature of honest but impractical attempts to ward off the approach of infected individuals from New York City, healthy adults and children from the city were subjected to inconvenience, great injustice and even to inhuman treatment. Railroads and other common carriers appealed for assistance and it was decided that so-called health certificates, or more properly travellers' identification cards, should be issued to those who presented themselves at certain offices of the Department of Health for medical inspection and could prove residence at an address from which no case of poliomyelitis had as yet been reported. Between this date and July 18th these certificates were issued by the Department of Health, and only after examination of the applicant by a physician of the Department. On July 18th, 25 officers of the Public Health Service were assigned by the Surgeon General to the control of interstate transportation in the interest of preventing the spread of the disease. Later, twelve more physicians were added to this staff, all operating under Senior Surgeon Charles E. Banks. The supervision of travel, as enforced under the provisions of the interstate quarantine regulations, was as follows (extract from report of Senior Surgeon Banks):

> "Children 16 years of age, and under, were placed in a class of restricted travel and were not permitted to leave the city from July 18th until October 3d, without producing a certificate that the premises occupied by them were free from poliomyelitis, and had been

free from this disease since January 1, 1916. This was supplemented by a medical examination of such travellers at the point of departure. When these requirements were satisfactorily shown, a certificate of identification was issued, together with a duplicate of same immediately mailed to the health officer of the community to which the travellers were destined. As required by law, common carriers (railroads, steamboats, etc.) were obliged to refuse entrance to trains or boats of this restricted class unless so provided with the certificates. The essential basis of this certification was the information furnished by the New York City Board of Health covering the immune condition of the premises of intending travellers, and full credence was given to this aid in the execution of the measures undertaken by the Public Health Service in preventing the spread of the disease through interstate travel.

"These regulations were enforced at every rail or ferry terminal, and steamboat pier, in New York City, and as far as possible automobile traffic leaving the city by other avenues was included."

The objects achieved, from the standpoint of those engaged in this work in New York City, may be stated as warranting the following conclusions:

First. There resulted a stabilization of public opinion through the presence of regular officers of the United States Public Health Service, trained in the management of epidemics, who were assigned to duty in New York City. This was crystallized through the uniform approval of the metropolitan press, with its continuous favorable references to the work accomplished.

Second. The work affected a standardization of methods adopted by local quarantine officers of other states through co-operation with the plan of certification above described. Harsh restrictive measures had been adopted in many localities because of the absence of knowledge of the extent of the epidemic and lack of information of the origin of travel into their communities.

Third. It afforded the local health authorities a certain security in locating arrivals in their jurisdiction immediately, and instituting such measures of isolation, or limitation of movements for a given period as they deemed wise.

Finally, it constituted a demonstration of the need of a centralized authority, with power to deal with interstate problems relating to the transmission of disease by common carriers, backed by congressional statute. The Quarantine Law of February 15, 1893, was the keynote to the administration of the work of the officers of the United States Public Health Service in the measure employed by it of certification and notification to health officers of travel to their localities.

FORM OF TRAVELLERS' IDENTIFICATION CERTIFICATE ISSUED.

DEPARTMENT OF HEALTH
CITY OF NEW YORK

I hereby apply for a certificate that there has been no case of poliomyelitis at my address.....,

Borough of.....

.....
(Signature of Applicant)

This is to certify that the records of the Department of Health of the City of New York show that no case of poliomyelitis has been reported from.....,

Borough of.....

Date....., 1916. Issued by

.....
(Name and Title)

On July 15th the Police Department was requested to report all removals of families within the city or to points outside, so as to facilitate the tracing of contacts and reported cases which disappeared before the diagnosis was confirmed.

On July 20th it was found necessary to follow up the cases isolated in their homes with much more care, as repeated instances of violation of quarantine were reported. To this end, 35 motorcycle police, obtained by a call for volunteers, were assigned by the Police Commissioner to the Health Department. They called on all home cases every other day, alternating with the visits of field nurses of the Department of Health.

CONTROL OF PLAYGROUNDS.

This day saw also an organized effort, for the recreational facilities for children, take definite form and produce substantial results, as confidence in the safety of the playgrounds took the place of suspicion and panic. As soon as the quarantine regulations in regard to poliomyelitis were put into effect, it became increasingly evident that the usual work performed by the Department of Health and various agencies of the city, relative to fresh air outings for children, would be appreciably checked. In fact, almost immediately towns outside New York City refused to accept any children sent from the city. In consequence, summer camps were closed, fresh air outings stopped, and, in many instances, children were barred from playgrounds and public baths.

All child-welfare workers were keenly alive to the danger that threatened, and the Fresh Air Federation of New York took immediate steps to meet the situation. The Department of Health, in co-operating with this federation, devised ways and means whereby substitutes were found for the fresh air outings so generally relied upon during previous summers. The reports of the various settlements and of the Fresh Air Federation of New York will give in detail the individual work done by these organizations.

In this survey it is only necessary to state that, while a far greater number of children were kept in town during the summer than during previous summers, it was possible, through the joint efforts of the Fresh Air Federation, the Department of Health and the Department of Education to open public shower baths in the various schools of New York City. In this work the Bath Committee of the office of the Borough President of Manhattan co-operated very closely and the Board of Education's Committee on Care of School Buildings was informed that the Fresh Air Federation was willing to operate the school baths if permission could be obtained simply to open the school buildings for the purpose. It was found that about forty of the public schools in Manhattan were equipped with shower baths but that the program of the Board of Education provided for the opening of only about half this number. Under the auspices of the Board of Education there were twenty-two baths in Manhattan, one in The Bronx and seven in Brooklyn open for the summer of 1916. Through the efforts of the Fresh Air Federation, eight additional baths were opened. In addition, all baths operated by settlements were widely used.

Energetic efforts were made by the Fresh Air Federation to increase the out-of-town facilities for fresh air parties, but marked resistance was met in this direction. Quarantine against New York was rigidly maintained by practically every town within reasonable distance of New York City, and the only solution of the problem seemed to be educational work which would induce mothers to take their children outdoors, and the provision of proper play space. Such work was carried on with vigor by the Department of Health and the various fresh air agencies.

During the early part of the summer, the authorities in charge of the various playgrounds and recreation centres for children of the city were impressed by the possible danger that these places afforded for the means of transmitting poliomyelitis, consequently a considerable number of them were closed, although no order had been issued by the Department of Health to this effect. As it was felt that the use of these recreation centres was of the utmost importance in providing the necessary fresh air and play space for children, investigation was made by the Department of Health to determine whether or not the playgrounds and centres were being operated in accordance with the regulations of the Department of Health, relative to (1) the use of the daily contagious disease lists and (2) the provision of proper medical supervision.

It was determined that these playgrounds and recreation centres could

be safely operated under the supervision of the Department. Accordingly, investigation was made of each playground. Careful instructions were given to the authorities in charge of the playgrounds to the effect that, each morning, the daily list of contagious diseases must be carefully checked up with relation to each child admitted to the playground on that day, and that every child belonging to a family in which a case of infectious disease had occurred must be excluded from attendance at the playground. The following instructions were also given to those in charge of the playgrounds and centres:

1. A competent person, such as a graduate or well-trained under-graduate nurse, should be employed at each centre to inspect the children each day. Any child showing signs or symptoms of any illness whatsoever must be immediately excluded from attendance at the centre and the facts reported to the Department of Health, giving name, address and reason for exclusion.

2. In the supervision of children at play centres, the following points must be observed:

(*a*) Sand boxes are not to be used.
(*b*) Children should play in small groups.
(*c*) Games involving bodily contact are not to be allowed.

The authorities of the playgrounds were also informed that the Department of Health could not provide the necessary medical and nursing supervision and that the authorities must provide the daily inspection required, that there must be a nurse or physician connected with the playground to whom debatable questions might be referred.

Those in charge of these various centres were notified that failure to observe the orders issued would result in the immediate closing of the play centre. It is of interest to note that during the entire summer no instances of violations were reported nor were any instances of the transmission of infectious disease noted, although careful inquiry was made regarding this point.

Owing to the fact that during the early summer few, if any, children went to the playgrounds, it is not surprising that the attendance was considerably lower than during the same period of 1915. The exact statistics are given herewith:

	1915.	1916.
No. of playgrounds maintained.....	193	177
Playgrounds open	July 5	July 3
Playgrounds closed	Aug. 17	Aug. 18
Total attendance	4,089,977	2,726,216

Conference of Scientists Requested by the Board of Estimate and Apportionment.

On July 27th a special appropriation was made by the Board of Estimate and Apportionment, at the request of the Department of Health for funds to defray the expenses of scientists, whom it was thought necessary

to invite, to give the Department of Health the benefit of all information and their judgment on the management of the epidemic.

On August 3d there assembled, at the invitation of the Board of Estimate and Apportionment, a notable group of the ablest investigators in the field of experimental medicine and leaders in the science of prevention of disease. Every facility was given them to learn the exact situation in New York City from a detailed description of the epidemic to date, and by personal study in the field, in hospitals and in the laboratories of the city. Their report follows:

REPORT OF THE CONFERENCE COMMITTEE ON POLIOMYELITIS.

"DR. HAVEN EMERSON,
"Commissioner of Health,
"City of New York.

"DEAR SIR—Having been called to New York at your suggestion and for the purpose of consulting with you concerning the practical measures employed in dealing with the present epidemic of poliomyelitis, we offer the following statement:

"We have spent two days in studying the situation and investigating prevailing conditions.

"On Thursday morning, August 3d, we went over with you the history of the origin and spread of the epidemic of this year. We made a careful study of your maps and diagrams showing the number and distribution of cases in the different boroughs of the city. This was followed by a discussion of the methods that have been employed both here and elsewhere in attempts to control the spread of the disease.

"In the afternoon of the same day we visited Willard Parker Hospital and made a careful inspection of the treatment and care given by the city to the children afflicted with this disease.

"Thursday evening we had a discussion concerning the methods being employed and the possibility of making these more efficient.

"On Friday morning, August 4th, we visited cases quarantined in their own homes and in this way were able to compare the hospital care with the home care of the sick. We also made a survey of certain crowded infected districts and with a diagnostician we visited certain homes in which cases have been recently reported.

"Friday afternoon we gave to a more formal discussion and the suggestion of definite recommendations.

"We have given special attention to the methods now employed by you and your department and we approve of the measures you have taken.

"The weight of opinion favors the view that infantile paralysis is mainly spread through personal contact, and measures have been directed chiefly from this point of view. Cognizance, however, has been given to additional methods of transmission, among which is the bite of insects. For sanitary purposes it is proper to consider that this disease is transmissible directly from the sick to susceptible persons or indirectly from the sick through carriers.

"Even with our incomplete knowledge of the dissemination of the disease, it is evident that in seeking to abate the epidemic stress must be specially laid upon two things, as is now being done:

"1. The early recognition and notification of the disease, and

"2. The immediate isolation of patients and cases of suspicious illness.

"Furthermore, on account of incomplete knowledge concerning the disease, measures known to be effective in checking the spread of other infections should be applied and these are, particularly, personal hygiene, cleanliness of person and surroundings and care of food, which should be thoroughly cooked.

"In order to secure the earliest possible recognition and notification of cases and their prompt isolation, we wish to direct particular attention to the appeals that have been made by the department to the physicians of the city and the public generally that they co-operate with the department in all these measures.

"We strongly recommend that you inaugurate a house to house inspection of as large a part of the city as is practicable twice a week, for the purpose of educating and of securing the early recognition, notification, and isolation of the disease.

"We are of the opinion that satisfactory isolation is secured only in hospitals. Moreover, not only is more thorough protection secured for the public by the hospitalization of patients, but it is also better for the individual patient.

"There is still much to be learned concerning the period of incubation, accurate methods of early diagnosis in non-paralytic cases, modes of transmission and the length of time persons continue to carry the infection, and in view of these factors, a scientifically adequate method of control is impossible at the present time.

"The committee recommends the closest co-operation possible among the different laboratories and investigators that may undertake the investigation of problems connected with epidemic poliomyelitis.

"The Committee would suggest the following problems as especially desirable for investigation at this time:

"1. Methods of culture of the virus of poliomyelitis, with especial reference to corroboration of previous work, to simplification of methods, and to the distribution of the virus in the body of patients.

"2. The immunologic reactions of patients and supposed carriers of the virus, and others.

"3. The virulence in animals, of the crude virus, in order to determine if possible whether there are any differences in the virus causing outbreaks in different parts of the country as well as to discover perchance more susceptible animals for experimental purposes than are now available.

"4. The microscopic study of the secretions of the nose and throat and of the intestinal contents of patients suffering from poliomyelitis, persons who have come in close contact with such patients and others.

"5. The transmission of the disease by insects and domestic animals and other possible modes of transmission.

"6. The study of practical methods of disinfection

(Signed)

Dr. J. F. Anderson	Prof. J. W. Jobling	Dr. Francis W. Peabody
Prof. C. C. Bass	Prof. L. Hektoen	Prof. Richard Pearce
Dr. George Draper	Dr. C. H. Lavinder	Prof. M. J. Rosenau
Dr. Simon Flexner	Prof. Paul A. Lewis	Prof. Theobald Smith
Dr. W. H. Frost	Dr. E. Libman	Prof. Victor C. Vaughan
Dr. Joseph Goldberger	Dr. G. W. McCoy	Prof. Hans. Zinsser
Prof. John Howland	Dr. Hideyo Noguchi	Dr. A. Wadsworth

The immediate result of the recommendations was the organization of house to house visits, with a corps of nurses under the direction of a committee representing various nursing and field agencies, life insurance companies and the Department of Health.

Day and Week of Greatest Incidence of the Disease.

The day upon which the committee of visiting scientists first met fell upon the point of greatest daily incidence of the disease, according to the reports of cases to the Department of Health. Two hundred and seventeen cases were reported on August 3d. The following week, August 5th to 12th, also recorded the greatest number of cases and deaths with a total of 1,151 cases and 301 deaths from poliomyelitis. From this time, each week showed a decrease in the epidemic until on November 6th no cases or deaths from the disease were reported. Cases have occurred in small numbers each week since this time, but only in the way recognized for some years past as characteristic of the endemic or sporadic expression of the disease.

Permanent Committee on After-Care of Infantile Paralysis Cases Organized.

On August 4th the patients, in whom the onset had occurred before the first week in June, were already reaching the end of the period of isolation required by the Department (8 weeks), and in most of them the crippling deformities resulting from paralysis were of a degree needing immediate and continuous expert orthopaedic, neurological and nursing care. The certainty that the hospitals and relief agencies which, in the past, have met such needs, would be unprovided for the great increase of service soon to be demanded, and the probability that many of the dependent parents of the crippled children would be unfamiliar with the facilities available for their treatment and relief, pointed to the need of organized efforts for the after care of discharged patients. Representatives of orthopaedic hospitals and relief agencies were invited to meet on August 7th. Following this informal conference there was formed a permanent organization, liber-

ally assisted to the extent of paying the expenses of a central directing and office staff, by the Rockefeller Foundation. From this time on, all patients discharged at the end of the isolation period from the Department of Health or other hospitals were, at the same time, reported to the central office of the Permanent Committee on After-Care of Infantile Paralysis Cases. As soon as the arrangements were perfected by which each case was assigned to the appropriate district agency, every case was visited, and assisted, or merely kept under observation as conditions warranted.

The spirit of loyal and unselfish co-operation shown by the great number of agencies, lay and medical, which have now created a well managed organization of inestimable value to the city, cannot be too highly praised. A further contribution of this group was made when it was decided in October that the constituent societies should forego their individual opportunities to obtain financial aid, for the sake of having a single appeal made to the public for funds to support their joint campangn of relief and treatment for the next two years.

Committee on House to House Visits Organized.

On August 5th the Committee on House to House Visits was invited to carry out the suggestion of the scientists above referred to. The following societies were represented, and by their liberality, public spirit and devotion to a difficult social experiment added to the debt the city already owed them for notable services in the interest of public health in the past.

Manhattan—

New York Association for Improving the Condition of the Poor.
Charity Organization Society of New York.
Henry Street Settlement.
United Hebrew Charities of New York.
University Settlement.

Brooklyn—

Brooklyn Association for Improving the Condition of the Poor.
United Jewish Aid Society of Brooklyn.
Brooklyn Bureau of Charities.
Brooklyn Society for the Aid of Crippled Children.

Meetings were held on August 7th, 8th and 10th.

The following report was submitted on September 22d as the result of the work accomplished under the administrative direction of the Department of Health, with 32 field nurses contributed by the co-operating societies. In addition to the special inquiry carried on by the nurses, a contribution of services for the distribution of circulars and leaflets of information was made by the Metropolitan, Prudential and Home Life Insurance Companies and their field agents, and by the University Settlement. The last named contributed 24 workers, 2 hours a night, and 2 nights a week:

> "It was decided to designate two areas over which to work. The first included the area between Delancey street, Essex street,

East Houston street and Ridge street, Borough of Manhattan. The other was bounded by Irving avenue, Greene avenue, Central avenue and DeKalb avenue, Borough of Brooklyn. It was decided to carry on a house to house inspection of these two areas for the purpose of reporting cases of poliomyelitis found; to enforce quarantine where required; to report to the Department of Health violations of quarantine; to instruct the individual families regarding proper sanitation of the apartments and rooms, under which was included proper cleaning of premises, proper care of foods, proper hygiene in relation to the care of children; proper disposal of garbage and waste material; proper care of hallways, areaways, yards and streets; proper water supply, and the distribution of literature by means of which a certain amount of personal education was aimed to be accomplished by the nurse detailed to the work.

"In order to carry out this program more effectively two forms were devised for general use. The first in the form of sheets and intended for the use as a daily record. This form included a first page on which appeared the address, borough, character of house visited, and the general sanitary condition of the house, yard and areaways. Upon this page was also entered the date of the visit, the location of the apartment, the number of adults, the number of children from 0 to 5 years of age, the number of children from 5 to 15 years of age, the number of cats, the number of dogs, and information as regards infestation of rats and mice. Upon this form was also entered the personal instruction given by the nurse to each and every family. This was entered under the date of the visit and was for the purpose of providing the nurse with a record to which she could subsequently refer upon succeeding visits to the same premises. She was required to enter the results of her work subsequently under the same space as was entered the original visit until her instructions were finally complied with. When instructions were complied with it was required to enter the date on which such compliance took place. The second page of this form contained the same information as above described with the exception of the general characteristics of the house.

"The second form which was devised for general use was a mailing card. Mailing cards were numbered and each nurse was provided with a specified number, the numbers all in sequence and entered in a register book in the department. It was easy at a moment's notice to ascertain the number of reports which the nurse had sent in by simply asking her the number of cards which still remained in her possession. These cards were not used for anything but official reporting purposes. Upon this card was entered the name, age and address of the individual family inspected and the date of inspection. The personal hazards reported were noted on this card where the case was one of suspected poliomyelitis but any other infectious disease, such as diphtheria, scarlet fever, typhoid, etc., were reported in by the nurse. Other illnesses were reported as to their character and whether or not they were suspected as regards poliomyelitis. Cases noted 'charitable' were also reported in and turned over to the proper societies for action. Other hazards which were reported were bad housing conditions, unclean tenements, overcrowding, violations of the food laws, dirty streets, cellars and yards,

garbage and litter, disorderly or illegally occupied premises, and other nuisances. Reports coming under the jurisdiction of the Tenement House Department were forwarded immediately through official channels. The executive officer of the Department of Health, in charge of this work, placed himself in personal communication with the Commissioner of the Tenement House Department in order to obtain special action upon these complaints. Complaints involving the Bureaus of the Department of Health were immediately forwarded to the appropriate officer. A record was made in the office of the House to House Visiting Committee of the Department of Health as regards complaints received, who from, character of complaint, date, and to whom referred, which has been entered in the form of a book record.

"On the 14th day of August, 1916, nurses were assigned to this work. A total force of 32 finally concluded their work on the 20th day of September. Each nurse was assigned to a specified district in the above described areas. She was required to visit each and every house in her district daily. All nurses were required to visit the Department of Health each Monday at 9 A. M. in order to report officially the results of their work during the week and were required to present daily notations which were revised by the executive officer, and personal instructions were given to each nurse.

"During the period between August 14th and September 20th, the following activities of these nurses in the various boroughs were recorded:

"Number of houses visited	1,668
"Number of families visited	10,348
"Number of houses revisited	4,446
"Number of families revisited	33,426
"Number of suspected poliomyelitis cases reported	17

"Of these, the actual number found to be true cases were 9, of which 4 had been previously reported.

"Other cases of illness	160

"Of these 14 were measles, 3 diphtheria, 17 whooping cough, 7 chronic myelitis, 11 pneumonia, 15 recovered measles.

"Total number of infectious disease cases (other than poliomyelitis) found	67
"Cases previously reported to the Department	26
"Found to be 'No Case'	67
	"160

"One is struck with the fact that so few cases of poliomyelitis have been reported by these nurses and of those reported, so few were found to be true cases.

"Great difficulty was found in the earlier visits to induce janitors to keep stairs, hallways, yards and areaways in a clean and sanitary condition. It was found necessary for the Department to use its authority in many instances, if only to oblige the individuals in charge of houses to place them in proper sanitary condition.

" One of the most flagrant violations from a sanitary standpoint seems to be a habit of throwing garbage and rubbish out of the windows. In spite of earnest efforts made by the entire force, this was only remedied to an exceedingly insignificant degree. Another point brought out was the fact that a sufficient quantity of water is not supplied, especially from the third floor up. This is due to the fact that the tanks on the roofs are not properly cared for; the janitors do not see that they are filled at the proper time. A large number of complaints have been forwarded regarding this violation.

" It was found by the nurses that especial care was exercised by the mothers of the children from birth to 2 years of age. In other words, during those months when the child was helpless the mother took fairly good care of it. As soon as the child was able to take care of itself, to a certain degree, neglect by the mother followed.

" It was noted throughout the districts that few flies have been present this year. These are usually of the common house variety, green flies usually infesting street carts where fruits are exposed. Few green flies have been reported in the house. The districts, however, especially Manhattan, have been heavily infested with rats and mice. Large numbers of stray cats have been reported and removed.

" All nurses detailed to this work reported that they were fairly well received in a large percentage of instances. Parents accepted their advances in the light of education and, in the majority of cases, complied with their requests. They understood the work as being directed against the transmission of a highly contagious disease and most nurses who were detailed to this work expressed satisfaction as to the results, from a general sanitary standpoint, which they obtained. The nurses instructed the parent how to care for the children's noses and throats, and as to the danger of contact.

" The principal sanitary violations remedied were the dirty personal habits of children; lack of bathing of children; neglect of toilets, yards and cellars; improper water supply; improper feeding of children; improper care of foods; improper protection from flies; bad housing, bad plumbing, food violations as regards exposure; uncovered garbage cans, and improper disposal of garbage.

" An analysis of the report as regards orders complied with and orders partially complied with, shows that approximately 80% of families visited complied wholly or in part with the sanitary instructions of the nurses. While it is impossible to say whether or not this experiment was effective against poliomyelitis, it can be stated confidently that it was of great value from a sanitary standpoint of appreciable value from an educational standpoint. The systematized visiting of houses, continually, for a certain length of time impressed upon the minds of the inhabitants of these districts the importance of sanitation in the proper care of children. These ideas will be retained for a greater length of time by the children ranging from 10 to 15 years of age; in fact, much of the active work which has been accomplishel was through the children of this age. Results obtained among adults were largely due to fear of authority and the force of the department and not to voluntary action on their part."

So far as serving as an additional reliable means of limiting the spread of the epidemic is concerned, it cannot be claimed that the results justified the labor and expense of the procedure. The discovery of 9 true cases (not previously reported) in five weeks, by 32 nurses, is the net result of this study from the point of view of control of poliomyelitis. There is no good reason to believe that these 9 cases would not have been reported at a later date, but these cases should nevertheless be credited to the survey of the limited areas visited.

As a demonstration of the value of personal intensive education applied to tenement dwellers, the experiment was a success, and measured by the conditions found in the last days of the visits and by the diminution in sanitary violations discovered, it is fair to say that there was an improvement of 80 per cent. over conditions first observed. Such results may be expected to follow any such special effort, but permanent improvement does not necessarily result. At the beginning of an epidemic, the widest use of house to house visits to discover cases and to abate nuisances is most desirable. Undoubtedly the results would have been more striking had this study been undertaken early in July.

Decision as to the Opening of the Public Schools.

On August 8th a decision was reached which aroused much public comment at the time and later.

The date already set for opening the public and parochial schools was September 11th. The records of previous epidemics in this country and abroad indicate that the attendance of children at school had played no part in the spread of the disease, either among those attending school or in the community at large. The unprecedented virulence and extent of the existing epidemic, and unfamiliarity with the disease, has engendered in the public such a state of mind that concession to public alarm seemed advisable. All phases of the situation were thoroughly discussed by the Advisory Committee on Poliomyelitis, and the question submitted by mail to such members of the Mayor's Advisory Committee as were no longer in the City.

It was thought that more harm would come to the majority of the children of the city from a prolonged postponement of school opening than could be expected from possible exposure to the disease under school conditions. In view of the probability that the abatement of the epidemic would be so well established and so generally recognized by the public, by September 25th, and in view of the improbability of the attendance at school in any way determining a recrudescence of the disease at that time of year, the decision was given to the Board of Education as follows:

(August 15, 1916.)

> "Unless there should be a very marked and unexpected reduction in the incidence of poliomyelitis during the next three weeks, the Department of Health will recommend that the opening of the public schools be postponed at least until September 25th, and that

the exact date be fixed later and announced to the public press not less than two weeks in advance. Any recommendations of the Department of Health concerning the postponement of school opening will apply only to such schools and classes as are attended by children of sixteen years or less. Neither the schools, which admit only students over sixteen, nor the Training Schools for Teachers need have their opening postponed after September 11th."

(September 11, 1916.)

"Nothing in the progress of the epidemic has occurred which would justify any change in the date as at present agreed upon.

"The continued abatement in the epidemic indicates that there will be so small a number of cases of poliomyelitis by September 25th that no further postponement of the school opening need be considered."

On September 11th, a further conference was held and final approval was given to the decision previously reached.

In spite of the protests of certain alarmists, whose fears got the better of their judgment, the schools were opened on September 25th and not only was there no increase among children of school age following this, but there was a steady decrease in the number of cases throughout the city, continuing the abatement of the epidemic which had by that time become well established, as can be seen from the following brief statement of cases reported for the five weeks from September 10th to October 14th.

Cases of poliomyelitis in children 6 to 16 years of age, inclusive:

Week.	Cases Reported.
Sept. 10–16	36
Sept. 17–23	21
(Schools opened Sept. 25.)	
Sept. 24–30	22
Oct. 1– 7	21
Oct. 8–14	10

Cases of all ages:

Sept. 10–16	252
Sept. 17–23	156
Sept. 24–30	142
Oct. 1– 7	96
Oct. 8–14	72

When the schools opened certain precautions were taken to avoid the introduction either into the city or, particularly into the schools, of any children who had been recent residents in places outside the city where, perchance, the method of isolation and control did not give the same degree of protection which was required in New York City.

Arrangements were perfected to provide adequate medical supervision for the schools on the opening day, the procedure being as follows:

All children who had resided in New York City for a period of at least two weeks before the opening of school, and in whose families no

case of poliomyelitis had been reported within a period of eight weeks, were allowed to enter school at once. Children who had resided out of town within the two weeks period prior to the opening of school were excluded from school attendance until the two weeks residence in New York City had been completed, unless they were able to show certificates signed by the health officers of the towns in which they had resided, stating that they had not been exposed to an infectious disease and that they were in good physical condition.

The United States Public Health Service records of the incidence of poliomyelitis outside of New York City were consulted, in the case of all children who were excluded because they had resided out of town during the two weeks period, and could not present proper health certificates. If the town wherein a child had resided was found to be in an "infected area" according to these records, the child was required to remain out of school until completion of the two weeks residence in this city. If the town in question was found to be in an "uninfected area," the child was readmitted to school at once.

The practical carrying out of this program meant the inspection and supervision of over nine hundred thousand children in the public and parochial schools of the city. The inspection of all these children was practically completed on the opening day of school and it was found necessary to exclude nineteen thousand children from school attendance. The names and addresses of these children, with the place of former residence outside New York City, were referred back to the central office of the Department, where they were investigated and the decision reached as to whether or not such children should be readmitted to school.

Owing to the length of time required to investigate each name separately, it was found impractical to do otherwise than to exclude from school attendance for the full two weeks period from the opening of school all children who were unable to present proper health certificates.

The private schools of the city opened somewhat later and at varying intervals. The same procedure, however, was carried out with relation to the children entering such schools. In these instances, each school was notified of the regulations of the Department and required to report to the Department of Health the names and addresses of all children who were unable to comply with the regulations in question.

It is of interest to observe that since the opening of the private schools, only one case of poliomyelitis has occurred among children attending such schools and, in this instance, no secondary infection occurred. In the public and parochial schools the number of cases occurring after school opened was practically negligible and, again, after careful inquiry it was determined that no secondary cases developed as a result of infection among children of school age.

The opening dates of schools, academies and colleges within the city, where the students were over 16 years of age, were not altered at the re-

quest or order of the Board of Health, and no cases among those attending, either students or teachers, were reported.

Appeal for Funds for Braces.

On August 8th, also, was sent out an appeal for funds for the purchase of the appliances such as permanent braces which many of the children were in need of at the time of discharge. Such mechanical devices as were ordered by the surgeons in charge of the Department of Health hospitals for the patients' treatment, during the isolation period, were provided at city expense, as were medicines, nursing care, etc.; but for the permanent equipment of these crippled patients with orthopaedic apparatus it was not considered that the city should be charged. In response to this need, the public, individually, and through the press, made generous response, so that a total of $44,752.03 was received. Such part of this as was not expended when the Department no longer had this problem to meet was turned over to the general fund of the Permanent Committee on After Care.

Due acknowledgement of the individual contributions was made by the Department of Health, day by day, through the newspapers.

Entomologist Appointed.

On August 11th an important temporary addition to the professional staff of the Department of Health was made in the person of Charles T. Brues, Assistant Professor of Entomology of Harvard, who served the city for two months, and during that time carried out, with the assistance of the officers of the Public Health Service and various members of the staff of the Department of Health, investigations in the field of possible insect transmission of the disease. Although the results of his study were inconclusive, as have been all previous studies in this direction, the report (see page 136) is of value in throwing additional light on certain disputed points and in eliminating some insects from further consideration.

Other Important Activities at this Time.

Following special orders, issued on August 11th, important action by the Department was taken:

(1) Investigation was begun of all cases of poliomyelitis in the Borough of The Bronx, with the possibility in mind that transmission might occur through milk. The results are reported under the chapter on Epidemiology.

(2) Janitors were held responsible for observation of quarantine regulations by tenants, and thus more effective observance of the law was obtained from this date forward, according to the daily reports of field nurses and police.

(3) To further insure universal compliance with and respect for the quarantine regulations, inspections were made twice daily in certain parts

of the city, to detect wilful violators, and summonses were issued where justified. The courts gave prompt and unequivocal support to the Department in such cases.

Conference of State and Territorial Health Officers at Washington, D. C.

On August 17th a conference of State and Territorial Health Officers, with the United States Publc Health Service was held at Washington, D. C., following a telegraphic call sent on August 9th, as follows:

> " Under authority of public health law 1902, a conference of State and Territorial Health authorities with the Public Health Service is called to meet at 10 A. M., Thursday, August 17th, to consider the poliomyelitis situation and bring about greater uniformity in methods of control. Representation of your State is urgently requested. Wire the name of your delegate."

The Commissioner of Health of New York City was asked to attend and report upon the methods employed and the results so far observed in New York City.

The program of the meeting was as follows:

" Call to order by the Surgeon-General.
" Remarks by the Secretary of the Treasury.
" The poliomyelitis situation in the various States.
" The prevention of the interstate spread of poliomyelitis.
" The research problems in poliomyelitis.
" The symptomatology of poliomyelitis.
" The epidemiology of poliomyelitis.
" General principles of control.
" The relation of the community to the after-care of poliomyelitis patients."

There were no suggestions offered which justified any change in the methods of control adopted in New York City, and there was general approval of the efforts made to check the spread of the disease within the city and to neighboring states.

Three committees were appointed, and their reports as well as a complete record of the transactions of the conference may be found in the issues of the United States Public Health Reports, Vol. 31, Nos. 34, 35, 36.

Dead Dogs and Cats.

August 19th. The great number of cats and dogs found dead upon the streets and collected by the American Society for the Prevention of Cruelty to Animals when found at large was explained at this time on inquiry, not by the presence of any disease, but by the fear of householders, and the general inclination on the part of the public to rid their premises of vermin and pets.

Use of Immune Serum in Treatment.

From the early weeks of the epidemic promising therapeutic procedures were employed under carefully controlled conditions in the Department of Health hospitals, and through specially trained diagnosticians in the patients' homes, where very early or suitable cases were found. Among these, one which had much to recommend it, upon theoretical grounds, was the use of the blood serum of recovered patients, that is so-called immune serum, from the fact that a person who has recovered from the disease, so far as is known, does not again acquire the disease if exposed, and from the further evidence of animal experiments that the blood serum contains some immunizing properties.

Through the activities of physicians and surgeons, many former patients were persuaded to make the personal sacrifice necessary to supply blood for the treatment of the patients in the present epidemic. General publicity brought additional offers, and private funds were given to the Department of Health to reimburse those who were making this contribution at considerable personal expense.

In order to give every chance for the most comprehensive study of this treatment, a citizens committee was formed, upon the initiative of one particularly public-spirited man who had already made his own contribution to the supply of immune serum.

On August 22d the matter took definite shape, a circular letter from the committee, a letter from the Department of Health, and an illustration being issued to people who were known to have had poliomyelitis:

Citizens Committee to Obtain Serum for Infantile Paralysis.

"*To Those Who Have Had Infantile Paralysis:*

For the purpose of co-operating with the Department of Health in obtaining serum for the children who have contracted infantile paralysis in the present epidemic, a Citizens' Committee has been formed.

The serum is made from the blood of those who have had the disease, and it is hoped, and the Department of Health has urged, that as many as possible of the boys, girls, men and women, who themselves have suffered from the disease, and who do not weigh less than 70 pounds, will give their blood to prevent the lifelong sorrow that comes from it. The enclosed copy of a letter from Dr. Emerson, the Commissioner of Health of New York City, explains the attitude of the City Officials.

The blood is collected by means of a fine hollow needle thrust into a vein at the bend of the elbow, and, as Dr. Emerson states in his letter, the collection of blood is practically painless and causes no inconvenience. It will be done by the doctors of the Department of Health. Enclosed herewith is a picture which shows the simple way in which the blood is taken.

Any public-spirited persons willing to give their blood should go either to

The Willard Parker Hospital,
16th Street and Avenue B (Foot of East 16th St.),
Borough of Manhattan,
and ask for Dr. Abraham Zingher, who will be there between 9 and 4 o'clock, and on Saturdays between 9 and 12 o'clock.

or to

The Brooklyn Office of the Department of Health
Flatbush Avenue and Fleet Street,
Borough of Brooklyn,
and ask for Dr. Samuel Parnasse, who will be there between 3 and 5 o'clock including Saturdays and Sundays.

Those who, for any reason, are unable to go to those hospitals, either because they cannot use the customary means of conveyance, or cannot go at the times stated, should communicate with John S. Billings, M.D., Deputy Commissioner at the Department of Health, 139 Centre Street, New York City whose telephone number is 6280 Franklin, in order that appointments may be made to supply transportation to the hospital or for doctors of the Department to visit the homes of such persons. The Committee has arranged to provide the Department with the means of conveyance. As the blood serum is sometimes impaired by transportation, those giving their blood are strongly urged when possible to visit one of the hospitals. The Department of Health will not take blood from any persons who are under twenty-one years of age without the consent of the parents or guardian."

(Signed) LEWIS L. DELAFIELD, JR., Chairman.

Public Letter.

"One of the most promising methods now being tried for treating the little victims of infantile paralysis consists in the spinal injection of blood serum obtained from persons who have had the disease. At the present time, large amounts of this serum are urgently required.

"Among the residents of the city, there are many hundreds who have had infantile paralysis in the past, and who are therefore in a position to supply the serum needed to treat the patients now in the hospitals. Your suggestion that a Citizens' Committee co-operate with the Department of Health in canvassing the city for prospective blood donors and in arranging the various incidental details is a happy one, and I cordially accept the aid thus proffered. If necessary, the Department will be very glad to detail competent physicians to collect blood in the homes of such donors.

"The procedure by which the blood is collected is practically painless and causes no inconvenience. In fact, not even a bandage is required."

This picture shows the simple method used for extracting blood from which to make serum for infantile paralysis.

In response to this appeal, and through the assistance provided by the committee, considerable amounts of blood serum were obtained. The full report as to the result of the use of such immune serum is included under the section on Treatment, page 264.

EXTRA SERVICES FOR THE DEPARTMENT OF HEALTH DISCONTINUED.

On September 3d the abatement of the epidemic justified the return to their regular duties of some of the special police squad assigned to inspection and enforcement of quarantine, where patients were isolated at their homes. At the end of two weeks, all extra police officers were returned to their usual duty. By this time, the daily reports of cases had fallen to the number reported in the first week in July, but with this important difference that while it was well recognized in June and July that many unrecognized and unreported true cases existed throughout the city, now only 30 per cent. to 40 per cent. of the cases of sickness supposed to be poliomyelitis were found by the diagnosticians to be true cases, and therefore included in the daily report.

On September 9th all restrictions were removed from play blocks, moving picture theatres, carnivals, etc.

On September 23d the services of some of the employees obtained through the emergency appropriation were discontinued, and a week later it was found possible to release all the temporary force engaged in field work. The peak of the emergency load, from the hospital point of view, was reached considerably later (6-8 weeks) than was the case with the field work, and the extra nurses in the department hospitals were kept until the ward service fell off, after all transfers from private hospitals had been accomplished and the normal census of patients had been reached.

On September 27th all placards were removed from the outside of private houses, and from the main entrance and hall of tenement and apartment houses, which was apparently causing some hardship to the owners of vacant apartments offered for rent. The placarding of all premises was considerably modified.

On October 4th the supervision of interstate traffic by the Public Health Service was discontinued, and all excluded children were admitted to public and parochial schools.

On October 19th the Advisory Committee on Poliomyelitis held its last meeting at the Department and recommended that the Department of Health require 6 and not 8 weeks quarantine. The policy of hospitalization was endorsed.

DECLARATION THAT IMMINENT PERIL NO LONGER EXISTS.

On October 31st the following resolution was passed by the Board of Health:

> "The Board of Health at a meeting held July 5, 1916, issued its declaration that great and imminent peril existed to the public health

of the people of the City of New York, by reason of an outbreak of poliomyelitis (infantile paralysis) throughout the City of New York, and

"Whereas, The Board of Health having taken and filed among its records what it regards as sufficient proof to authorize the declaration that the epidemic due to the prevalence of polimyelitis (infantile paralysis) has modified to such an extent that the great and imminent peril to the public health no longer exists, be it, therefore,

"Resolved, That the Board of Health hereby declares that the great and imminent peril due to the prevalence of the epidemic of poliomyelitis (infantile paralysis) in the City of New York, is no longer deemed to exist."

On November 6th, for the first time since the first week of June, no new cases or deaths from poliomyelitis were reported to the Department of Health.

On November 28th the quarantine period of six weeks was re-established by resolution of the Board of Health.

Circular of Information Regarding Procedure.

The procedure in force during the epidemic is well described in the following circular of information:

Incubation Period: The incubation period of the disease, and the quarantine period of children under sixteen years of age who have been, but no longer are, exposed to infection, has been set at fourteen days.

Quarantine: In all families where a case of poliomyelitis has occurred, all the children under sixteen years (except those who have had the disease) are quarantined in the home until two weeks after the termination of the case by death, removal or recovery. The patient, whether at home or in hospital, is quarantined for eight weeks from the date of onset of the disease. No case in hospital may return home until quarantine is ended.

Placards: All premises where a case of poliomyelitis occurs are placarded, the only exceptions being hotels and boarding houses, which are not placarded provided patient is at once removed to hospital, the room or rooms immediately disinfected, and no quarantined children remain on the premises. In private houses, one placard is placed on the street wall of the house, and one on the door entering room the patient occupies. In apartment and tenement houses, three placards are posted—one on the street wall, one on the wall of the entrance hall, and one on the door of the apartment. All placards must be dated and initialed.

Removal to Hospital: No case may be left at home unless the following conditions are complied with:

(a) There must be a physician in daily attendance.

(b) The patient must have a special attendant, who must obey quarantine regulations and must not do any housework, marketing or perform any household duties for other members of the family.

He or she can, however, leave the house provided the necessary precautions as to personal disinfection, etc., are observed, but should avoid all children.

(c) The patient and the attendant must have a room, or rooms, separate from the rooms of others in the family.

(d) All the windows of this room must be screened and all files in the room killed.

(e) The family must have a separate toilet for its exclusive use.

(f) Quarantine regulations must be strictly observed by the patient and the other children of the family, if any. When the disease occurs in the premises of families of food handlers, the employment of such person or persons at this occupation is forbidden, unless they occupy entirely separate apartments, for a period of two weeks after the removal, recovery or death of the patient.

(g) *Disinfection and Renovation:* The personal and bed linen of the patient must be properly disinfected and, after removal, recovery or death of the patient, complete renovation of the room or rooms occupied by the patient and attendant is required.

Duties of Inspectors:

Cases are reported by physicians, nurses, social workers and other citizens, and all are visited at once by inspectors, even those reported by physicians with request that they be admitted to hospital. Attending physicians to Department Hospitals may admit cases direct, without inspector's visits.

The janitor or his representative must be seen in every instance and notified that he or she will be held personally responsible by the Department for keeping quarantined children in the family premises, and seeing that placards are not removed or defaced.

If the inspector makes or confirms the diagnosis of poliomyelitis, the Borough Office of the Department is notified and by it the ambulance is summoned, if removal is indicated. In every case the inspector leaves the hospital admission slip, properly and fully filled out. When case is left at home, inspector must give full instructions to family.

All cases of questionable diagnosis must be seen at once in consultation with the Borough or Chief Diagnostician, and whenever it is required, spinal puncture will be made and laboratory report submitted by the staff of the Research Laboratory. Cases with positive laboratory findings will be considered as poliomyelitis, regardless of clinical signs. A full history must be recorded on a special card (Form 316-V) for each assignment covered by inspectors.

Duties of Nurses:

Nurses will visit every case reported, to instruct the family regarding quarantine, and every other family in the house:

(a) That there is a case of this disease in the house

(b) That the other children of the family in which the disease has occurred will be quarantined, and that, should they fail to observe quarantine, that fact should be immediately reported to the Depart-

ment of Health, when steps will be taken to enforce quarantine by a summons to Court.

(c) Regarding home cleanliness, personal hygiene, the danger of infection by flies, and other general measure which should be taken to prevent infection.

(d) To report at once to the Department any cases of suspicious illness of children, or any cases of poliomyelitis, especially if there is no physician in attendance.

A current history (Form 304-V) must be kept by the nurse for every case, giving dates of visits, action taken and date and mode of termination.

Nurses must see the janitor or his representative on first visit, and repeat the instructions given by the inspector.

Patients remaining at home and families with quarantined children are visited daily by the nurse or patrolman for the maintenance of quarantine, and oftener if necessary. After removal, recovery or death of the patient, nurses issue renovation notices, following these up by visits until complied with.

Duties of Sanitary Police:

These officers visit frequently—daily, if necessary—quarantined premises, to enforce quarantine of patient and other children in the family, and to affix or replace placards. They serve summonses when quarantine regulations are violated and appear in Court.

Ambulance Surgeons:

All cases ordered removed to hospital must be removed by the ambulance surgeon without question, with the following exceptions, in each of which the ambulance surgeon must first obtain telephone authorization from the Resident Physician of his hospital, to leave the case at home:

(a) When removal would endanger life of child (bulbar cases).

(b) When family physician can show that requirements will be met at once (or within 12 hours).

Doubtful and mixed infection cases must be removed by themselves in a separate ambulance.

In every case ambulance surgeons must leave a card with parents, giving name and address of hospital to which patient is taken. If inspector has not left admission slip, surgeon must make out same.

Visitors to Hospitals:

Each case may be visited twice during its stay in the hopsital, by a parent or guardian. If child is critically ill, the guardian or parent will be notified and will be permitted to visit daily, while child is dangerously ill. Information relative to condition is given out at the Information Desk in each hospital, or by telephone in response to telephone inquiry from the parent or guardian.

Certificates for Children Leaving the City:

The Department of Health of New York City does not require certificates of anyone leaving or entering the city. It issues certificates only as a convenience and aid to persons leaving the city. None are issued to persons passing through the city.

Such certificates state that the persons or family therein named have not resided in a house where a case of poliomyelitis has occurred. The applicant must sign a request for the certificate. They are refused to persons who live in a house where a case of infantile paralysis has occurred, or who present symptoms of the said disease.

The certificates are good only until midnight of the following day, except when issued on a Saturday or on the day preceding a holiday, when they are good until midnight of the second following day.

Persons Leaving New York State: Officers of the U. S. Public Health Service, stationed at transportation terminals, require the above certificates before they will permit children under 15 years of age, resident in New York City, traveling to points outside of the State of New York, to leave the city. The original applicant must again sign the certificate in the presence of the Federal Health Officer. Federal Health Officers do not require certificates of any adults.

Persons Going to Points Within New York State: Residents of New York City, adults or children, traveling to points within New York State, who present certificates of good health from their family physicians, may also obtain the above certificates from the Department of Health. If no physician's certificate of good health is presented, applicants will be examined by a physician and their freedom from symptoms of poliomyelitis certified; in this case, all children must be brought to the proper office of the Department.

Return of Cases of Poliomyelitis to New York City:

Cases of poliomyelitis occurring in residents of New York City who are temporarily residing outside the city, and developing within two weeks of the time of leaving the city, will be permitted to return, provided (a) a private conveyance (private car, private automobile, carriage or ambulance) is used, and (b) the patient goes direct to a hospital authorized by the Department of Health to care for cases of poliomyelitis.

Cases in which the onset of the disease occurs two weeks or more after leaving the city, may not return to New York City until eight weeks from the date of onset of the disease. But in special cases, where proper medical, surgical and nursing care is not obtainable, patients may be brought back to the city in a private conveyance, providing they go directly to a private room in a private hospital authorized by the Department of Health to receive cases of poliomyelitis.

Return of Children Who Have Been Exposed to Poliomyelitis to New York City:

Children under sixteen outside of New York City who have been exposed to infection with poliomyelitis within two weeks, may return to the city under the following conditions:

They must come by private conveyance and must go direct to their homes.

Advance notice must be sent, and authorization obtained, by telephone, by the local Health Officer. Such notice must give the name and age of each child, together with the identified address, including the floor, and the latest date of exposure to infection, and must be followed immediately by a written notice.

Such children will be promptly visited at their homes by a representative of the Department of Health, and instructed as to nature and duration of quarantine. They must not leave the premises until two weeks have elapsed from the date of last exposure to infection.

The premises are not placarded, but the children are visited at regular intervals, and should quarantine be violated the parents or guardians are summoned to Court and fined.

Important Miscellaneous Activities.

Special mention is due to certain aspects of the epidemic and of the official work of the City during the epidemic, not falling logically within the scientific treatment of the subject which constitutes the chief and most valuable part of this report. These are:

A. The co-operation of the various City Departments.

B. The legal controversies and decisions resulting from the enforcement of the procedure authorized by the Board of Health.

C. Steps in procedure by the Department from time of report of a case until its recovery, removal or death.

D. The account of expenses authorized under emergency condition existing.

E. Suggestions as to the causes and cures for the disease.

A.

From the beginning of the epidemic, generous and voluntary assistance was given to the Board of Health and the Department of Health by the Mayor and his commissioners. From the following departments especially valuable co-operative service was received:

Police Department:

Extra efforts to enforce compliance with all City ordinances bearing upon sanitation of streets.

Special force of volunteer cycle policemen assigned to Department of Health to enforce quarantine.

Support of the Department of Health in obtaining compliance with the unusual restrictions put upon public gatherings.

Record of all removals of families within and between boroughs.

(Face of card.)

NAME	DATE	BOROUGH	YEAR

AGE Years SEX Male—Female MARITAL STATE Married—Single—Widowed COLOR White—Black NATIONALITY (Of Mother, if minor) OCCUPATION

ADDRESS: STREET NUMBER FLOOR ROOM NO. CARE OF

F. B. N. S. E. W.

REPORTED BY ADDRESS DATE

THE HOUSE GENERAL CONDITION NUMBER OF FAMILIES

STABLE NEAR? (YES) (NO) EXPOSED GARBAGE, &c. NOTED? (YES) (NO)

THE HOME: GENERAL CONDITION (GOOD) (BAD) FLIES (YES) (NO) VERMIN (YES) (NO)

THE FAMILY: ADULTS CHILDREN ON PREMISES SINCE

0—5 years 6—10 years 11—20 years

EXPOSURE TO INFECTION: ANY CONTACT, DIRECT OR INDIRECT, WITH OTHER CASE? (YES) (NO)

DETAILS, DATES OF CONTACT

INSPECTOR'S DIAGNOSIS ONSET: DATE

PARALYSIS: WHEN FIRST APPEARED PARTS AFFECTED

GENERAL SYMPTOMS: RESPIRATORY GASTRO INTESTINAL

TYPE: 1 ABORTIVE 2 SPINAL 3 MENINGEAL 4 CEREBRAL LUMBAR PUNCTURE: DATE RESULT

PRECAUTIONS OBSERVED: ISOLATED (YES) (NO) DEATH FROM

FOOD HANDLERS IN FAMILY (YES) (NO) REPORT CHILDREN ATTEND SCHOOL AT EXCLUDED

REMOVAL AND RENOVATION ORDERED ASSIGNED TO RETURNED

316 V—1916 DEPARTMENT OF HEALTH, CITY OF NEW YORK—POLIOMYELITIS 16-B-10,000

The card used to record all cases after the diagnosis was established or confirmed by physicians of the Department, was as follows:

(Reverse side of card.)

REMARKS:

FIELD OFFICE RECORD:

RECEIVED ACTION TAKEN

REMOVED TO HOSPITAL: DATE TIME

FORWARDED CARD

CENTRAL OFFICE RECORD:

SERIAL NUMBER TABULATED FORWARDED CARD

SPECIAL ASSIGNMENT:

REMARKS:

Tenement House Department:

Supplementary and extra inspections in tenement premises where violations were found or cases reported.

Original study of relationship between case incidence in tenements and the number of families per tenement.

Street Cleaning Department:

Flushing of all paved streets at least once every 24 hours, throughout the congested tenement quarters of each borough, by assignment of extra squads for night work.

Extra collections to insure prompt removal of household waste and street sweepings.

Department of Licenses:

Enforcement of restrictions put upon places of public assembly.

Board of Education:

Assistance through the principals and teachers, in obtaining exclusion of children at the beginning of the school year, in accordance with requirements of the Department of Health.

Department of Plant and Structures:

Providing generous addition to the motor passenger service when the necessity for rapid transportation for physicians and nurses became acute.

Civil Service Commission and Department of Finance gave the Department instant and obliging assistance in the many cases of unusual demand it was forced to make for personal service and the use of emergency funds.

B.

Legal Activities of the Board of Health of the Department of Health of the City of New York During the Epidemic of Poliomyelitis.

Powers, Jurisdiction and Authority of the Board of Health.

The legal activities growing out of the outbreak of poliomyelitis in the City of New York afforded a splendid opportunity for considering the powers and duties of the Board of Health and the Department of Health of the City of New York during the presence of a serious epidemic of disease, which necessitated the exercise of the extraordinary powers vested in the Board of Health to act in such an emergency. A short résumé of the law governing the action of the Board and the more interesting and important questions arising as a result of its enforcement may be of interest and value and are, therefore, briefly considered in this report.

The various statutory provisions under which the Board of Health exists, and which define its powers, jurisdiction, and authority, will be found in Sections 1167 to 1325, both inclusive, of the Greater New York Charter. The sections which particularly enumerate the powers of the Board are Sections 1168, 1169, 1170, 1172 and 1178.

The Board of Health, by virtue of the provisions of Section 1172 of the Greater New York Charter, is authorized and empowered to adopt the Sanitary Code, which embraces regulations on a general variety of subjects connected with the public health and is a permanent code of health laws covering all the ordinary contingencies and circumstances which require intervention of public authority for the security of life and health.

The Greater New York Charter makes a violation of the Sanitary Code a misdemeanor, and the punishment for a misdemeanor is imprisonment in the penitentiary or county jail for not more than one year, or a fine of not more than five hundred dollars, or both. Discretion, however, is vested in the trial court as to the degree of punishment to be imposed in any particular case. In addition to the criminal penalty, the Charter also provides that a violation of the said Code subjects a party to a penalty in the sum of fifty dollars to be recovered in a civil action. In determining to what court to submit a violation, the Department of Health's action is governed by the offense, and the more serious violations are submitted to the criminal courts for determination.

The provisions of the Sanitary Code which provide securities against the spread of infectious diseases, including poliomyelitis, will be found in Article 7, Section 86 to 103, inclusive, thereof.

To supplement the provisions of the Sanitary Code and to prescribe, in more detail, the duties and obligations imposed by the provisions thereof, the Board of Health is empowered to adopt regulations which have the force and effect of law in the City of New York. Section 1262 of the Greater New York Charter also makes a violation of such regulations a misdemeanor.

It is perhaps unnecessary to recall the fact that the powers vested in the Board of Health to adopt the provisions of the Sanitary Code have been repeatedly sustained by the highest courts of this State.

The sections of the Sanitary Code hereinbefore referred to were in force and effect prior to the outbreak of the epidemic poliomyelitis in the City of New York, and no change or alteration was made during its existence. However, in addition to the provisions of the Sanitary Code, the Board of Health at a meeting on July 5, 1916, in accordance with the provisions of Section 1178 of the Greater New York Charter, declared that great and imminent peril to the public health existed, due to the outbreak of poliomyelitis in the City of New York.

In addition to such declaration, the Board adopted regulations governing the quarantine, removal, care and treatment of persons suffering from anterior poliomyelitis and procedures to be followed by the Department of Health in the enforcement of such regulations.

The above briefly indicates the provisions of law in force during the existence of the epidemic of poliomyelitis, and it provided the basis upon which the Department of Health might act in all emergencies.

Administrative Action.

The Department of Health is the administrative branch of the Board of Health and is charged with the duty of enforcing all laws applicable in the City of New York, including the Charter of the City of New York, the Sanitary Code, the Regulations and the Orders of the Board of Health of the Department of Health of the City of New York. The Board of Health, in adopting the Sanitary Code and the Regulations particularly relating to Poliomyelitis, provided a legal basis for the action of the Department of Health. Under the direction of the Commissioner of Health, who is the executive officer of the Department of Health, these provisions of law were enforced in a reasonable and uniform manner during the prevalence of the epidemic.

The attitude of the public, generally, was in accord with the action taken by the Board and it voluntarily complied with the conditions imposed by the Code and the Regulations, although in many instances it necessitated personal self-sacrifice. In a few instances—considering the number of cases existing—it became necessary, however, for the Department of Health to take drastic action, by forcibly removing cases to the hospitals or by prosecuting persons who neglected or refused to comply with the conditions imposed by the Sanitary Code and the Regulations. A short résumé of the facts upon which these prosecutions were based will be considered in this report.

The legal work performed in behalf of the Department was not, however, limited to cases arising out of the enforcement of the laws relating to poliomyelitis. The Department, in co-operation with other departments under the jurisdiction of the Mayor of the City of New York, instituted a "clean up crusade," which had for its purpose the general sanitary improvement of the City. The departments principally interested, besides the Department of Health, were: the Street Cleaning Department, the Tenement House Department and the Police Department.

The action taken was predicated upon the various provisions of the Sanitary Code relating to sanitation generally and the care and preservation of food and drink. As above indicated, a violation of the provisions of the said Code is a misdemeanor.

As a result of the crusade, a large number of prosecutions were instituted in the criminal courts. The courts co-operated with the City officials to the fullest extent, and in all cases where the offense charged was sustained by sufficient evidence, substantial fines were imposed. As a result of the action taken, the general sanitary conditions throughout the City were greatly improved and the sale of foodstuffs on the streets were effectively regulated and controlled.

One other feature of the legal work performed was the prosecution of unscrupulous persons engaged in the despicable practice of selling worthless preparations as preventions and cures for poliomyelitis to the gullible

public. It is a well-known fact that on all occasions of great public anxiety or peril, ignorant and conscienceless individuals take advantage of the condition existing and commit acts which warrant the severest punishment. These medicine fakirs were particularly active during the epidemic, and the efforts of the Department were centered on bringing them to justice. Fortunately, the action taken by the Department was immediate and drastic and the conviction of six individuals was obtained and a number of others forced to go out of business. The circumstances surrounding this particular class of prosecutions are interesting, and the facts of a few cases instituted will be briefly dealt with later.

Criminal Actions Instituted During the Epidemic.

(Actions instituted in the Supreme Court.)

A most interesting case arose out of the action of the Department in removing from a private dwelling to the hospital a child suffering from poliomyelitis, contrary to the wishes of the parents, and because of their failure to conform with the requirements of the Quarantine Regulations adopted by the Board of Health. The parents of the child applied to the Supreme Court, Kings County, for a Writ of Habeas Corpus to compel the Department to return the child to the custody of its parents. The facts of the case are briefly as follows:

> Robert Anderson, residing at 180 New York Avenue, Jamaica, Borough of Queens, City of New York, was reported to the Department of Health by an attending physician, as suffering from poliomyelitis. This diagnosis was verified by the District Diagnostician of the Department of Health. Subsequently, the parents called in another practicing physician, who pronounced the child to be suffering with malaria and not with poliomyelitis. Upon being informed of this fact, the Department of Health had the child examined by the Chief Diagnostician of the Department and the Borough Diagnostician of the Borough of Queens. They confirmed the original diagnosis and determined that the child was ill with poliomyelitis. The parents also procured the services of another physician, who confirmed the diagnosis of the previous physician employed by the parents, and held that the child was not suffering with poliomyelitis. The parents, in spite of repeated warnings, instructions, and notifications of the Department of Health, both written and verbal, refused and neglected to isolate the child and to take the ordinary necessary precautions to prevent the infection of other children in the family and in the neighborhood.
>
> Great publicity was given to the case in the daily newspapers, and exaggerated reports as to the action and requirements of the Department of Health were published.
>
> The facts and circumstances of the case, showing as they did an utter disregard of the rights of the public to protection against the spread of the disease, necessitated the Department in taking drastic action and forcibly removing the child to a contagious disease hospital. Acting under orders of the Commissioner of Health, in accordance with the provisions of Section 97 of the Sanitary Code,

a copy of which is hereinafter set forth, the child was removed to the Queensboro Hospital.

The parents thereafter made the application to the Supreme Court for the writ of habeas corpus. The case occupied the attention of the Court for four days, during which time medical expert testimony was submitted in behalf of both sides. The Department of Health, in its behalf, submitted the testimony of several physicians in its employ, who, by virtue of their training and experience, had an intimate knowledge of all the symptoms of the disease, as well as the testimony of two eminent physicians not officially connected with the Department, which testimony was all to the effect that the child was suffering from poliomyelitis in the convalescent stage of the disease. In addition to the expert testimony submitted, the testimony of nurses and other employees, tending to prove the breach of the quarantine regulations was given. The petitioner submitted evidence of two physicians, which was to the effect that the child was not suffering from the disease. The testimony of the mother and others, in regard to the facts and circumstances surrounding the removal of the child as well as the conditions existing prior to such removal, was also submitted.

The attorneys for the petitioner contended: that the Department of Health exceeded its powers in acting in the manner it did; that the child was not suffering from poliomyelitis; that there had been no breach of the quarantine regulations, and that the regulations were unreasonable and arbitrary. The Corporation Counsel contended: that the Board acted within its powers in adopting Section 97 of the Sanitary Code and the regulations of the Board of Health governing the quarantine, care and treatment of persons suffering with poliomyelitis; that the child had poliomyelitis at the time of his removal by the Department, acting in accordance with the provisions of Section 97 of the said Code, and that there was a violation of such regulations, justifying the removal of the child to the hospital.

On motion of the Corporation Counsel, the Court dismissed the writ and remanded the child to the custody of the Superintendent of Queensboro Hospital for Contagious Diseases of the Department of Health.

It might be mentioned here that the petitioner waived the production of the child in the court, so that he was not present during the procedure before the court.

Section 97 of the Sanitary Code, authorizing the removal of the child is as follows:

"*Removal of Persons Affected with Any Infectious Disease Authorized.*—Whenever an inspector of the Department of Health shall report in writing that any person affected with any infectious disease, under such circumstances that the continuance of such person in the place where he or she may be is dangerous to the lives or health of other persons residing in the neighborhood, the Sanitary Superintendent, an Assistant Sanitary Superintendent, or the Director of the Bureau of Infectious Diseases, of the said Department, upon the report of a medical inspector of the said Department may cause the removal of such person to a hospital designated by the Board of Health."

Mr. Justice Garretson, in dismissing the Writ, rendered an oral opinion, sustaining the powers of the Board of Health to act under such circumstances. Brief extracts of this opinion are herewith set forth:

"THE COURT. (orally): I find that the Board of Health acted within its powers, so far as this case is concerned, in a public duty which it had to perform, not for the welfare of the child alone, although, of course, that never ought to be lost sight of. The welfare of the particular patient and the natural affection of his relatives are things that ought never to be lost sight of, but when there is a prevalence in the community of a noxious or contagious communicable disease, such as is shown in this case to have existed, it is the imperative duty of the Board of Health to act, and the Board is given broad general discretion to act for the benefit of the community at large and the public, whose rights, in such health matters, are paramount, and to which, under certain given circumstances the rights of private individuals must yield. The Board undertook to perform what they deemed to be their duty they were entirely within their powers, and I believe the facts of the case justified them.

"I am also prepared to hold, on the testimony in this case, that this child had poliomyelitis. I do not personally know that it had it —perhaps it did not, but taking all the testimony, beginning with the expressions of opinion that were made at the beginning of the history of the child's case, and coming down to the time this writ was sued out, and down to the present time, the testimony preponderates in favor of the Board of Health and necessarily compels the conclusion that this child had poliomyelitis at the time the quarantine was established. How grave and serious it was I do not know. It may have been a very slight case; I hope it was an exceedingly slight case. But I think the evidence justifies and compels me to that conclusion.

"The quarantine was established. The establishment of the quarantine was a matter within the discretion of the Board of Health. The duty of the Board of Health as conservators of the health and well being of the community at large, is to take charge and set apart from the rest of the community, cases of infectious or contagious or communicable diseases. That is within their particular powers. They are not bound to do that in all cases. They may do it in the exercise of their judgment. It is not alone a matter of right, but is also a matter for the exercise of their sound discretion. They may allow the patient, under conditions which will, in their judgment, be equally efficacious to the taking of the patient into a hospital, to remain in a private house, under certain rules and restrictions, with certain warnings, placards, and so forth. They are not bound, after once having established a quarantine to allow that quarantine to continue, nor do the patient or custodians or guardians of the patient acquire, by the establishment of the quarantine, an absolute right to have it continued. Its continuance rests in the sound discretion of the Board of Health. The Board must act in a reasonable manner, because, while these powers are broad and extensive and are, seemingly, almost arbitrary, there are certain rights which the people have and which the individual has, upon which they and he may insist. Those rights are that there shall be reasonable grounds, at least, for the exercise of these plenary powers of the Board of Health. * * *

" Private property cannot be taken and personal liberty cannot be restrained, even by Boards of Health, except where the facts in a particular case justify the finding that the Board or its authorized agents were acting upon facts which make their action reasonable and proper and necessary, in carrying out the paramount purpose of the existence of the Board.

" This good lady, the mother, tender, affectionate, cleaving to her child, wanting to have it at home was uncertain what she ought to do. She was inspired in the first instance by a sense of public duty, which told her that she ought to report the case or have it reported when the first doctor came in. She was evidently confused by the conflicting opinions of the medical gentlemen with whom she later came into contact. At first she seems not to have objected particularly to the quarantine. Later on, when at least two doctors, Dr. Smith and Dr. Flynn, gave their opinions, which were in conflict with the opinions of the other physicians, she thought that she might relax the duty which was imposed upon her by the quarantine regulations, and she did so. The safeguards which are recognized as necessary to be thrown around a case of this particular disease, were taken down and removed by her, largely upon the opinion of the two doctors to whom I have referred, Dr. Smith and Dr. Flynn, and naturally enough, too, because their opinions were in the line of her motherly affection and her motherly instinct, and in the line also of her personal desires as to herself, her children and others, that she should be free to receive anybody into the house and go into other houses and out upon the street, as though there were no communicable disease affecting this child.

" The Board of Health, under those circumstances, had a right to take the child, and do with it what it was permitted, under the law, to do in the first instance, but which, in the exercise of its discretion, it had not done. The Board of Health took the child from the custody of its parents and put it into the particular hospital which was set apart for that purpose. * * *

" Nothing is to be found here except these matters of fact which I have stated to you, which are based upon the evidence presented, and which matters of fact found by me are applied to the law of the case. The Court does not decide, as a matter of fact, anything outside the testimony in this particular case, and particularly not upon the scientific or medical aspect of the disease. It may be shown in the future that all this theory upon which it is sought to be demonstrated that poliomyelitis is a communicable disease, is wrong. The views of the medical fraternity, as at present expressed as the consensus of opinion of a majority, may be modified or may be confirmed, so it seems to me that such a determination on the part of this court would be just as futile as for the court to determine who was the author of certain literature, the authorship of which has been disputed for several centuries. This court will not undertake to determine any such question.

" But this all leads to the conclusion, and I so find, that the Board of Health acted within its powers in this particular case as the case is shown to the Court; that the quarantine was disregarded; and that the action of the Board of Health in taking charge of this child and secluding it was entirely within its powers, within its rights and within its authority. * * * "

One other case was instituted in the Supreme Court, involving the placarding of the outside door of a large apartment house. An application for an injunction *pendente lite* against the Board of Health and the Commissioner of Health, to require them to remove from and not replace on the outside main entrance of an apartment house premises certain placards announcing the presence of poliomyelitis in the apartment house, was made. The peculiar facts and circumstances surrounding the particular case in question resulted in the Court granting the motion and ordering the Department to remove the placards in question.

(Actions instituted in the lower courts.)

The prosecutions instituted against individuals for selling alleged medicinal preparations for the cure, prevention and relief of poliomyelitis are as follows:

Joseph Frook was charged with a violation of Section 118 of the Sanitary Code, in that he made false and misleading representations as to the kind, quality, purpose and effect of a certain alleged drug or medicinal preparation, offered and intended as a medicine, to the public. The alleged drug or medicine in question consisted of a bag containing cedar wood shavings, to be worn around the neck of the child affected with poliomyelitis. Frook was the manufacturer of this bag containing the cedar wood shavings and claimed that it would protect the child from death and would also prevent germs, insects, etc., from attacking the victim. Frook was also charged with a violation of Section 421 of the Penal Code, in that he published false and misleading advertisements in the daily newspapers. He was convicted and sentenced to thirty days in jail and to pay a fine of two hundred and fifty dollars.

James T. Manchester was charged with a violation of Section 118 of the Sanitary Code, in that he made false and misleading representations as to the kind, quality, purpose and effect of a certain alleged drug or medicinal preparation, to wit: "Sol," offered and intended as a medicine, to the public. The alleged drug or medicine in question consisted of a bottle containing essentially capsicin, sassafras and alcohol. Manchester was the manufacturer or this alleged drug or medicine, and claimed the preparation would cure infantile paralysis, consumption, rheumatism and other diseases. He was convicted and sentenced to thirty days in the City Prison.

Charles Stiriz was charged with a violation of Section 118 of the Sanitary Code, in that he made false and misleading representations as to the kind, quality, purpose and effect of a certain alleged drug or medicinal preparation, to wit: "Surmacyl," offered and intended as a medicine, to the public. The alleged drug or medicine in question consisted essentially of malt and salicylic acid. Stiriz was the manufacturer of this alleged drug or medicine and claimed the preparation would cure infantile paralysis. He was convicted and sentenced to thirty days in the City Prison.

Charles Smith, who claims to be one hundred and three years old, was charged with a violation of Section 118 of the Sanitary Code, in that he made false and misleading representations as to the kind, quality, purpose and effect of a certain alleged drug or medicinal preparation, to wit: "Protector to prevent and relieve Infantile Paralysis," offered and intended as a medicine to the public. Charles Smith was the manufacturer of this alleged drug or medicine and claimed the preparation would relieve, prevent and cure infantile paralysis. The court fined Smith five hundred dollars.

Gertrude Zabriskie, for a similar offense as that committed by Charles Smith, was fine three hundred dollars.

In addition to the aforesaid violations, a number of retail pharmacists were prosecuted and convictions obtained for the substitution of ingredients in prescriptions. Fines ranging up to one hundred dollars were imposed by the courts.

It might be well to mention that all actions instituted in behalf of the Department, involving this vicious type of violation of the law, were successfully prosecuted and very severe penalties imposed by the courts.

The following is a summary of the number of actions instituted in the criminal courts, and their dispositions, involving violations of the Quarantine Regulations:

	Interfering With Officer.	Violation of Quarantine.	Removing Placards From Doors.
Fined	3	6	..
Discharged	..	2	..
Sentence suspended	..	2	1
Total prosecutions	3	10	1
Amount of fines imposed	$30 00	$18 00	..

The following is a summary showing the number of actions, arising out of the activities of the Department of Health during the "clean-up" campaign, instituted in the Criminal Courts:

Department of Health.	Total.	Fined.	Sentence Suspended.	Prison Sentence.	Dismissed.	Amount of Fines.
Bureau of Food and Drugs	1,356	1,135	194	2	25	$3,057 00
Sanitary Bureau	573	275	188	1	109	1,271 00
Sanitary Police	337	279	28	..	30	599 00
Total	2,266	1,689	410	3	164	$4,927 00

The following is a summary of the criminal actions instituted by the Bureau of Food and Drugs against persons charged with violating the provisions of the Sanitary Code relating to the sale of drugs and medicines:

	Total.	Fined.	Sentence.	Prison.	Guilty, Pending Waiting Sentence.	Amount of Fines.
Number of actions instituted for false and misleading representations as to purpose and effect of drugs and medicines.	8	3	1	3	1	$850 00
Substitution of ingredients in prescriptions	2	2	..	..	..	200 00
Total	10	5	1	3	1	$1,050 00

C.

ACTION BY THE DEPARTMENT FROM THE TIME OF REPORT OF CASE UNTIL ITS RECOVERY, REMOVAL OR DEATH.

Reporting—

Article VII., Sanitary Code, Sections 86 and 87.

Sec. 86. Duty of persons in charge of hospitals and of physicians to report infectious diseases.

Sec. 87. Duty of every person to report persons affected with an infectious disease.

Isolation—

Article VII., Sanitary Code, Section 89.

Sec. 89. It shall be the duty of every physician immediately upon discovering a person affected with an infectious disease, to secure such isolation of such person or to take such other action as is or may be required by the regulations of the Department of Health.

Form for Reporting (395 V)—

Postal cards for reporting cases of infectious diseases are furnished, upon request, to hospitals, dispensaries, and physicians, free of charge.

This card contains a list, alphabetically arranged, of the diseases to be reported, also several paragraphs of information pertinent to assistance rendered by the Department.

The principal items to be reported of a case of infectious disease are printed on card so that full details desired are indicated.

Day List—

On receipt of a report, by card or otherwise, each morning, a list of the cases, classified by boroughs and by districts in a borough, is made by the stenographic bureau.

This list, together with envelopes addressed and postage prepaid, is sent by departmental messenger to the printer. Immediately after printing, the list is placed in the envelopes and at once sent by printer to Post Office.

Public, parochial, day schools of various character, social welfare, charitable institutions, libraries public officials and others receive this list daily, except Sundays and holidays.

The list is complete for the entire City and contains the name, age, address, and disease of each case reported for the previous 24 hours. Exception being only on days following Sundays and holidays, when the list is for the previous 48 hours. During the height of the epidemic, no exception was allowed.

Press Copy—

During an unusual incidence of epidemic disease, advance information for publicity is prepared as follows: The cases are reported to executive office by telephone, the list is then sent to stenographic bureau, which mimeographs the necessary number of copies required. 250 copies have been made within one hour, making it possible to give information as early as 10 o'clock each morning.

Diagnosis—

On receipt of a report of a case by telephone, postal, or personal complaint, the case is at once referred to a district diagnostician for confirmation of diagnosis. If a true case, the premises are placarded, and if it is practicable to leave the patient at the home, the family are instructed regarding regulations, and the epidemiological history card is made out.

If conditions of home and family are such that the regulations cannot be complied with and the case is a true one, the diagnostician orders the removal of the patient to the department hospital.

Should a consultation be required, the diagnostician confers with either the nearest district diagnostician, the borough diagnostician or the chief diagnostician.

Special cases or cases in dispute are always referred to the Chief Diagnostician, who considers the case until final disposition.

Home Quarantine—

The establishment of quarantine in the home is by the district nurse; she, having received the assignment from the branch office, visits the home, sees the patient, gives the family the necessary instructions regarding departmental regulation, excludes from school teachers and pupils in the family, placards if same has not been done, makes out history card and notes from date of next visit.

Revisits are made as the necessities of the case demand. In cases appearing to require careful supervision revisits are made daily or oftener. In others, at irregular intervals.

Police Inspection of Quarantine—

In order to maintain a strict supervision of home cases, the police (particularly of the Sanitary Squad) are required to visit the home and see that quarantine is being observed. The assignment is on a special card giving full instructions to the patrolman, and after visiting, the report is returned, the facts as found being entered on rear of card by officer.

Violations of Quarantine—

Violations of quarantine occurring, and such being detected, a nurse visits the premises at once and informs the family and warns them not to repeat under pain of removal to hospital of patient. The family physician is also informed and asked to aid in carrying out regulations. Where it is thought that a uniformed patrolman will have more influence with the family, one is sent in place of the nurse to inform and warn the family. Continued compliance not being obtained, the private physician is informed, a district diagnostician visits home, confirms the diagnosis, and if true poliomyelitis, directs removal of patient to hospital. The ambulance responds to such call

accompanied by surgeon, nurse and patrolman, and removes patient. The district nurse calls and issues instructions regarding renovation. Revisit is made later to see that same is performed.

Termination of Case—

On recovery, removal or death of patient, the nurse visits premises, directs disinfection and instructs family regarding renovation. Such being complied with, the placard is removed by the nurse, and quarantine is lifted. Teachers and children who were exposed are excluded from school for an additional two weeks except such as have had the disease, who may at once re-enter school. At expiration of the two weeks the nurse revisits and issues necessary school certificates.

Teachers and pupils who may have availed themselves of the special privilege of a change of address are now permitted to return to their home and are given a permit to attend school from home address.

Renovation (a) Voluntary; (b) Board Order—

On recovery, removal, or death of patient the nurse issues instructions regarding cleaning, repapering and repainting on a card "voluntary" renovation order. This order not being complied with, a report is made which is forwarded to the Board of Health, which issues an order on the owner directing compliance with same. If such is not complied with within a reasonable time and after warning, a summons to court is then directed and the case placed in the hands of the Magistrate for action.

Records—

Branch Office:

The branch office makes a tally card of case for assignment and revisiting. When nurse returns white history card, the two are filed in special file on date of next visit. On day of visit the history card is taken by district nurse and tally card left as check. Return of history card by nurse after revisiting, the two cards are again filed at date of next contemplated visit. On completion of case, tally is removed. History card is supervised and if complete is forwarded to Borough Office.

Statistical tabulations are made weekly and forwarded to executive office of Bureau.

Special reports or complaints regarding a case are investigated, and facts are subject of report to executive office.

Epidemiology—

Diagnostician on visiting a case makes out an epidemiological (blue) card and, when data is complete, forwards same to Division of Epidemiology.

From the data furnished by the various offices, this division prepares pin maps, charts, curves, statistical tables and forwards such reports as may be pertinent or desired from various sources.

Disposal of the Dead—

The body of a person dying of the disease must be promptly enclosed in a coffin which must be permanently sealed, and the funeral must be private.

Daily Borough Report.

Daily Report of Poliomyelitis in the Borough of ——— From 9 A. M. —— to 9 A. M. ——

No. of Inspectors on Field Duty.	UNITS.	No. of Positive and Suspicious Cases Reported.	No. of Assignments to New Cases Reported.	Positive Cases.				No. of no Cases.	Not Found.	Assignments Not Visited.	Visited but Held for Observation.
				No. of Cases to Go.	Isolated in Hospital.	Isolated at Home.	Dead; Not Previously Reported.				
TOTAL											

Percentage of positive cases Reported:.....

Borough Chief.

DAILY BLOTTER OF POLIOMYELITIS CASES.

Removed to Hospitals 9 A. M. *to 9 A. M.* 1916.

Borough of.....

Reported.		Assigned.		Reported Back.		To Stable.		Delivered to Hospital.		Elapsed Stable Time	Total Elapsed Time	Name of Hospital.	Removed From.	Home Address.	Removed	Not Removed	Name.	Age.
A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.									

TOTAL CASES FOR REMOVAL.....
TOTAL CASES REMOVED.....
TOTAL CASES NOT REMOVED.....
AVERAGE STABLE TIME.....
AVERAGE TOTAL ELAPSED TIME.....

"Stable Time" means elapsed time from hour stable receives call to delivery of cases to hospital.
"Total elapsed time" means elapsed time from receipt of report of case to delivery of case to hospital.

Daily Press Report.

From the Department of Health
City of New York

OFFICIAL

To the Editor:

A very large part of the work of the Department of Health depends for its success on the co-operation of an enlightened public, and this, in turn, depends almost entirely on the amount of space accorded to health articles by the newspapers.

If, when this reaches your office, your men are out on stories and you desire further information, we shall be glad to answer your inquiries over the telephone. Please ask for

THE BUREAU OF PUBLIC HEALTH EDUCATION
DEPARTMENT OF HEALTH
Telephone [redacted] 120 Centre Street, New York

PRESS BULLETIN 575 RELEASE Immediately.
Issued (Date) Sept. 23

	New Cases.	Dropped as no Cases.	Total Cases.	Deaths.	Total Deaths.	Discharged from Hospital, Recovered.
Manhattan	36	0	1,912	9	443	4
Bronx	13	0	424	3	95	0
Brooklyn	27	0	4,157	8	966	27
Queens	15	0	944	2	257	1
Richmond	1	0	276	3	49	2
Total	92	0	7,713	25	1,810	34

Total Cases in Hospital	3,924
Department Hospitals	2,474
Other City Hospitals	660
Private Hospitals	720
Swinburne Island	70
Vacancies	358
Cases Removed	71
Manhattan	27
Bronx	12
Brooklyn	22
Queens	9
Richmond	1

Certificates.

	Certificates Issued.	Certificates Issued to Date.	Certificates Refused.	Certificates Refused to Date.
Manhattan	700	34,007	4	172
Bronx	193	15,066	1	39
Brooklyn	941	45,538	2	190
Queens	205	9,160	0	4
Richmond	24	1,411	0	2
	2,063	105,182	7	407

New Cases and Deaths by Boroughs.

Name. Age. Address by Street and Borough

Here followed the list of new cases and deaths, arranged alphabetically, by boroughs:

D.

Emergency Expenses for Personal Service and Supplies Authorized by the Mayor, July 5, 1916.

The following tables show the number of the extra employees under classified headings on the payrolls of the Department for each week of the epidemic, from July 8th until September 30th. On this date the service of a large number of employees was terminated, but during the months of October and November a lesser force was retained in the hospital service for the after-care of the convalescing patients.

Positions Occupied Temporarily During the Epidemic of Poliomyelitis—July to September, 1916.

Positions.	Weeks Ending.													Months Ending.		
	July 8	July 15	July 22	July 29	Aug. 5	Aug. 12	Aug. 19	Aug. 26	Sept. 2	Sept. 9	Sept. 16	Sept. 23	Sept. 30	Oct. 31	Nov. 30	Dec. 31
Automobile Engineman	..	9	10	11	11	12	14	16	13	11	7	7	6	...	..	..
Bacteriologist	3	5	5	5	4	5	5	5	5	5	5	5	5	6	3	3
Clerks	..	3	9	12	13	15	21	21	20	18	16	16	11	...	..	..
Domestics	19	48	104	100	138	156	185	213	237	250	253	259	261	194	..	..
Entomologist	..	...	...	...	...	1	1	1	1	1	1	1	1	...	..	..
Helpers	..	...	5	5	5	5	12	10	11	14	14	14	14	12	15	15
Hospital Physician	1	1	1	2	2	5	6	5	5	5	6	7	7	4	..	..
Internes	10	22	23	34	40	34	29	31	34	35	40	28	31	26	..	..
Laboratory Assistant	..	...	3	3	3	3	4	4	4	3	3	3	2	3	3	4
Masseur	..	...	...	...	...	...	...	...	...	5	5	5	5	5	4	..
Medical Inspector	3	72	74	81	80	80	80	76	76	75	53	53	53	1	..	..
Nurses	68	159	194	214	255	337	381	403	422	433	430	419	404	172	..	..
Orderlies	..	1	3	9	19	25	28	28	29	27	26	24	23	14	..	..
Telephone Operator	..	1	1	1	1	1	2	1	1	1	1	1	1	...	..	..
Type. Copyist	..	...	...	...	...	...	...	2	2	3	2	3	3	...	..	..
Total	104	321	432	477	571	679	768	816	860	886	862	845	827	437	25	22

The actual amount of money expended for the payment of salaries of these incumbents is set forth in the following table:

Medical Inspectors	$15,951 61
Nurses	76,867 03
Clerks	2,703 07
Chauffeurs	2,519 10
Telephone Operators	148 76
Typewriting Copyists	384 88
Bacteriologists	2,422 52
Laboratory Assistants	843 02
Helpers	2,509 13
Entomologist	600 00
Hospital Physician	1,713 23

Domestic	17,671 81	
Orderly	3,492 20	
Interne	2,253 81	
Masseurs	1,435 27	
Increases in salary	17,490 83	
Medical Editor	300 00	
		$149,306 27

In addition to the above, personal service was furnished to other City Hospitals, over and above their regular force, at the following cost:

Nurses	$1,228 80	
Attendants	826 99	
		$2,055 79
Total Personal Service		$151,362 06

Cost of Supplies, Equipment, Materials and Service—

The following table shows by classes, the amount actually expended on poliomyelitis activities by the Department for everything outside of personal service and treatment of cases in private hospitals:

Supplies—

Food	$30,549 61
Office	3 60
Medical and Surgical	1,893 54
Laundry and Cleaning	326 96
Refrigerating	618 10
Motor Vehicle	215 38
General Plant	3,549 19

Equipment—

Office	$687 83
Household	29,794 26
Medical and Surgical	2,595 82
Wearing Apparel	10,986 60
General Plant	4,578 42
Motor Vehicles and Equipment	3,652 64

Materials	1,329 23

Service—

General Repairs	$2,133 07	
Motor Vehicle Repairs	1,135 02	
Hire of Automobiles	1,711 53	
Telephone	1,499 63	
Telegraph	201 89	
Supper Money	525 45	
General Plant Service	70 45	
		$98,058 22
In addition to the above, contract and open market order reserves have been established, as a further offset to the amount spent from the tax levy appropriation. This amount cannot be classified at present, but should be considered in total, as an additional cost of		24,922 80
Total Cost of Supplies, etc		$122,981 02

Summary of Cost—

Personal service	$151,362 06	
Supplies, Equipment, etc	122,981 02	
Treatment of cases in private hospitals	42,903 59	
Total		$317,246 67

As a point of interest, several articles are listed which were purchased in unusual quantities made necessary by the extraordinary number of patients treated in the hospitals of the Department:

2306 Children's cribs
33600 Bird's Eye Cotton Diapers
7428 Crib Sheets
7512 Bed Sheets
8208 Children's Nightgowns
211 Tanks Oxygen
26 Bales Cotton Batting

Transportation Service.

Under usual conditions the Department is supplied with four or five cars daily. This service was entirely inadequate during the epidemic, and it was necessary to have on immediate call twenty cars daily. Through the co-operation of the Commissioner of Plant and Structures the Municipal Garage furnished the Department with ten cars every day, it being under-

stood that this Department would supply the chauffeurs to man these cars. Even this arrangement was insufficient, and automobiles had to be hired to the extent of $1,711.53.

E.

Suggestions as to the Causes and Cures for the Disease.

It may not add to the sum of scientific data to quote the suggestions received by the Department of Health as to the cause and means of curing or preventing poliomyelitis; but as a record of human interest the letters sent from all over this country and from many foreign lands present a picture which it is well for health officers to bear in mind. One hardly knows whether to laugh at the fantasies or weep over the ignorance and superstition exhibited.

Two hundred and thirty suggestions as to the causes of the disease were received, the largest number of authors (80) attributing the existing calamity to foods. Ice cream, soft drinks, candy and summer fruits were generally accused, cereals and canned foods coming second in favor. All varieties of nuisances were accused (40), including smells, poisonous gases from the European war reaching here as the earth turns around, sewers, rubbish bags, automobile smoke, animals (wild and domestic), from the horse and cat to the man-eating shark and game birds. Personal contact, from the obvious to the impossible, was described by many as the proved cause of the disease, the public wet-wash laundry being particularly unpopular. Atmospheric conditions, " moisty air laden with coal gas and gasoline," " a condition similar to ' Bermuda High ' permeates the young child through the pores, reducing blood pressure," etc. All variety of insect pests, even including the tarantula, which was supposed to inject the virus into bananas shipped to New York City, were pointed out as obvious causes. Destruction of flies, which may live on poliomyelitis virus, was supposed to be the reason for increased incidence. The crusader against tobacco was convinced that the disease expressed the result of defects inherited from nicotine-soaked parents.

A few gems of description deserve special mention. A doctor of optometry from Vancouver, B. C., attributes the disease to the " disruption and destruction of the brain cells by the ultra violet rays of the sun; certain conditions of the eyes permitting of this pathological occurrence, the chemical action of these violent rays causing the development of a virus and bacillus, a failure of the circulation in the brain and spinal column to remove decomposed matter permitting germination and interrupts proper functioning, hence the partial or total paralysis."

A " High Priest of Iris " from Londonderry, Ireland, assures us that " Fine hydrogen from the earth is incarnated into the body, the paralysis resulting from the hydronizing of the parts affected."

A well-wisher writes from San Francisco to demand the suppression of all electrical companies. " The increasing amount of radio calls and wireless electricity in the air gives off vibrations which pass through children's bodies, act on delicate tissues and minute capillaries which press on nerves preventing nourishment, thereby causing paralysis."

Pollen of plants, subluxated vertebrae, maggots in the colon, tickling of children, are suggested by a number of writers.

" The cause may be linked to the use of the automobile which by their unclean fatty refuse give rise near foul water to a venomous putrefaction, which might offer elements of life to the 'plagues' spread. It goes to children particularly because of the fatty elements of the infective injections and the easy assimilation to the adipose parts of the child body. It is in relation to the increased proclivities of adaptation to the field of contagion that the epidemic carriers are apt to increase their venomous attributes."

In the matter of remedies, " cures," and preventives, imagination and memory ran riot. There were the " experienced mother," the public-spirited citizen offering to reveal a family formula for $1,000 to $2,500, the generous sales agent of patent medicines who would supply the formula if accompanying gallon sample gave good results, the layman from rural counties whose results in personal use of croton-oil, opium, and other powerful medicaments over the course of many years disclosed a lifetime of illegal practice upon a too gullible public.

In addition to these, there were 109 suggestions to use internal remedies from table salt (and no water) to a serum made from " blood of frogs " and intraspinal injections of fresh human saliva. Tonics of " boneset catnip, skullcap and lady slipper," inhalations of smoke of burning leather, free use of rum, champagne and brandy, all for little children, came strongly endorsed, though a few were so fanatical as to urge closing the saloons.

Forty helping minds described baths, from the useful warm water kind to those in liquid sulphide of iron, sand, mud, ice, blueing water, etc.

Thirty-two more had a certain remedy in disinfectants, to be used in every room in the city, or only in the nose, or on the hands of car conductors, etc.

Thirty-nine were sure the use of poultices, blisters, liniments, and healing oils would save every child-victim's life.

Here we renewed our youth by finding Jack and Jill and their " vinegar and brown paper " in the pharmacopoea. The suggestion of " earthworm oil " brings to mind the ingredients used, doubtless with as good effect by the witches in " Macbeth."

Of the special diets, garlic and onions were the most popular. Of course the practitioners of osteopathy and chiropraxy urged their services upon a suffering public with statements of cures.

Serum, whether of snake or human, horse or toad, was popular for a period.

Charms to be hung about the neck, red pepper, garlic, asafoetida, camphor, prayer, "power," spiritual preventives. Trances, electrical ionization, X-Ray, the "static modalities" all had their devotees, some making offers in all charity, others expecting a good round sum for their beneficence.

The prize suggestion came from abroad, in the form of the following description: "Place hydrogen conductors at soles of feet and hands, and cause attraction for this fine hydrogen by neg. electricity or neg. applications. Apply cantharides and mustard plasters. Diet must be high in fine oxygen, such as rice, bread and oxygen waters. Give oxygen through lower extremities, by positive electricity. Frequent baths using almond meal, or oxidizing the water. Applications of poultices of Roman chamomile, slippery elm, arnica, mustard, cantharis, amygdalæ dulcis oil, and of special merit, spikenard oil and Xanthoxolinum. Internally use, caffeine, Fl. Kola, dry muriate of quinine, elixir of cinchona, radium water, chloride of gold, liquor calcis and wine of pepsin." One's only embarrassment would be which one to use first.

Suggestions were acknowledged and in all instances in which there was any published clinical record of favorable results, the treatment suggested was submitted to the Medical Boards of the Department of Health Hospitals for consideration. As will be seen from the report of treatment at the hospitals, various therapeutic measures were carefully studied.

Results and Plans.

Most, if not all, the questions which have been asked upon two matters of first importance to the citizen, whether parent or merely taxpayer, cannot be answered without qualifications.

> What has been accomplished in the methods of controlling epidemic poliomyelitis?
>
> What is planned in order to prevent or control the next epidemic, when it occurs, next year, or in the more remote future?

It must be said that there is no positive proof that a demonstrable amount of protection or prevention resulted from the general measures enforced. That it is wise to separate the sick from the well as promptly as possible, after the detection of communicable disease, in epidemics, cannot be denied, and this measure of precaution must be accepted on general principles while awaiting such facts as may permit of the use of specific measures appropriate for this particular disease. Two apparently just inferences may be drawn from a study of the records:

1. **That hospitalization, when prompt and applied to all but moribund cases, probably checks the spread of the disease and determines a lower incidence under similar housing conditions than where removal to hospitals is delayed and many cases are left in their homes.**

In Brooklyn, only 46% of the cases suitable for removal were taken from homes to isolation hospitals. In Manhattan, 96% of the suitable cases were hospitalized, and the administrative machinery was more effective at the time when the majority of the cases were reported in Manhattan; hence, removals followed diagnosis more promptly than was the case in Brooklyn, where the full force of the epidemic fell before the emergency organization was well established.

It cannot be claimed that all other factors have been excluded, but it is nevertheless suggestive that in spite of greater congestion and apparently more opportunities for contact infection, because of the larger population per acre in Manhattan, the case incidence of the disease was .94 per 1,000 of population in that Borough, while it reached 2.24 in the Borough of Brooklyn.

2. Isolation of groups of children from contact with other children or adults, even when carried out in the midst of areas where the disease is prevalent, suffices to protect such children almost absolutely from infection, in spite of the use of identical water and food supplies, and exposure to the same atmospheric conditions and winged insects.

In support of this, the following facts are presented:

There were, during the epidemic, in New York City, 93 institutions for the permanent care of children, such as asylums and charitable homes with a total census of 21,746, and 76 institutions for the temporary care of children, such as recreation camps and convalescent homes, with a total census of 6,365.

All of these institutions were under the strict control and supervision of the Department of Health, and were notified on July 5th, by mail, and at different dates between July 5th and 14th, by personal visits of the inspectors, to discontinue the admission of visitors until further notice (rescinded Nov. 1).

The experience with the institutions for temporary care was as follows: In the Sea Breeze Home at Coney Island:

> One case developed on the afternoon of July 17th, within a few hours of admission, though with a normal temperature and apparently normal on medical examination on the morning of the same day.
>
> One case developed on August 26th, five days after admission.
>
> There were 2,087 inmates under sixteen years of age, during the summer.

In both these cases, there is no reason to doubt the existence of infection previous to admission.

At the New York Foundling Hospital:

One case was brought to the hospital with a developed paralysis and fever by the foundling keeper from her home, August 27th.

One case (S. S., age 4 years) developed the disease on July 30th, seven days after admission.

One case (G. G., age 2 years) developed the disease on August 8th, nine days after the previous case (S. S.) had been removed from the adjacent bed.

One case (S. R.) developed the disease on August 4th, and, though an inmate of another ward, was in the hospital during the stay of the child (S. S.) No direct exposure is known, nor could it be proved that a common nurse or attendant had served these two children.

One case (J. F.) developed the disease on September 19th. This child had been in the hospital for some time and the source of infection was not traced.

There were 650 inmates in the New York Foundling Hospital during the summer.

At the Home for Destitute Children:

The exclusion of visitors was not observed until July 14th. Three cases developed on July 18th, 21st and 24th, respectively. It was learned that after July 14th on several occasions visitors gained access to the children by irregular means, and the children were not infrequently taken out to walk in Prospect Park. It is worth noting that all three cases developed within the time accepted as the usual incubation period of the disease, 5 to 10 days after July 14th, when quarantine was undertaken.

At the Angel Guardian Home:

Quarantine was not observed until July 14th. One case developed on July 27th. This child had been an inmate of the institution for two years. No other cases of illness occurred in the institution during the summer which could be confused with non-paralytic cases of poliomyelitis. There were a number of cases in the vicinity of this institution, but the source of infection in this case was not traced. No secondary cases developed among the 600 inmates.

At the Sheltering Arms Nursery:

One case developed on July 1st. No secondary cases and no cases of any other disease developed during the summer, among the 116 inmates.

Among the institutions for the permanent care of children, two cases occurred:

At St. Joseph's Home, Flushing, one child (C. M.), who had been an inmate for two years, developed poliomyelitis on August 8th. Quarantine had been observed since July 14th. On the same day a child of the engineer of the institution, living in a house adjacent to the Home, developed the disease. The source of the infection was not traced. No secondary cases occurred, although the child (C. M.) had been kept from August 8th, when her first symptoms

of undefined sickness were developed, until August 13th (when the diagnosis was definitely established, and she was removed to the Queensboro Hospital), in the Baby House with thirty other children between two and six years of age.

At St. Joseph's-by-the-Sea, Huguenot Park, Borough of Richmond, one of the 97 children developed a disease diagnosed as poliomyelitis on August 23rd. At no time was the diagnosis positively established, and when death occurred on September 29th, after almost continuous unconsciousness since the onset, the autopsy did not give definite proof of the cause of death. No secondary cases occurred. Quarantine had been carefully observed since July 4th.

Allowing for the two weeks for incubation and development of cases after exclusion of visitors, and the observance of regulations at the various institutions, and eliminating the cases which came to institutions with the disease developed and cases in which the diagnosis was made almost immediately after admission, we have an astonishing evidence of the value of isolation of children of the especially susceptible ages out of contact with the rest of the community. We have furthermore good reason to feel that the precautions as to personal hygiene and management of groups of children in institutions suffice to prevent the spread of disease within their walls.

Two further important observations were made, leading to the conclusion that isolation of groups of children prevented their infection. There were between 80 and 90 children on Governor's Island, the United States Government Military post, throughout the epidemic. They were living under as nearly ideal sanitary conditions as may well be obtained. Absolute exclusion of all children visitors to the Island was maintained from July 4th. The children of the Island were not allowed to leave until the middle of September. No cases developed.

There were 350 children, under 16 years of age, on Barren Island in Jamaica Bay, Borough of Brooklyn. To this Island all the city garbage and offal is taken for reduction in the large rendering plants. Flies and mosquitoes are abundant. Rats are numerous. There is no public water supply and there are many shallow surface water wells. There is no sewage system. There are few, if any, cellars. There is no garbage collection. There are no public highways. The population of about 1,300 people represents the lower grade of unskilled labor, Poles, Italians and Negroes predominating. The standard of living is low. No cases of poliomyelitis developed on Barren Island. It is probably correct to say that social and geographical isolation of this Barren Island group accomplished by accident what was enforced by regulations at Governor's Island, namely, group isolation which was effective regardless of environment.

A result of great importance may properly be attributed to the educational campaign carried on among the mothers of little children. In spite of the large number of deaths from poliomyelitis, among babies and children under five, the ratio of deaths from all other causes among children in this age group were less than ever before in the history of the City.

With regard to possible or probable recurrence of the disease in epidemic form in the immediate future and the plans prepared for its control, no better statement can be had on the first point than is to be found in the report of the State Medical Institute of Sweden of 1912. "Those places which have once been severely affected by the disease have all prospects of escaping renewed severe outbreak of the epidemic even should this not occur until after the lapse of a series of years." "In all probability in the part of the population chiefly affected, there is a general and widespread immunity against a renewed infection."

In preparing to meet and control the disease if or when it reappears, we must, until new information as to carriers and means of transmission is forthcoming, rely upon *early diagnosis, prompt notification, hospitalization* or *equivalent home isolation, a well-informed public* and *an alert medical profession.*

During the recent epidemic, the medical profession, always the first line of defense against communicable disease, gave freely of its devoted service; the public acted in the main wisely in response to the appeal for quicker and better care for sick children; the quality of diagnosis rapidly improved with more general familiarity of physicians with the disease; prompt notification was the rule; hospitalization benefited the patients and safeguarded the public. These things have been accomplished, and our reliance upon them is wholly justified.

CHAPTER II.

Etiology.

Historical—

Until recently nothing was definitely known of the etiology of poliomyelitis. Within the last few years, however, a series of studies have been made which have added considerably to our knowledge of its cause and transmission.

In the spring of 1909, Landsteiner and Popper[1] succeeded in transmitting the disease to monkeys by inoculating them, intraperitoneally, with the spinal cord of a child who died of poliomyelitis, but they did not succeed in transmitting the infection from monkey to monkey, probably because they used too mild a case. Later, in 1909, Flexner and Lewis[2] obtained the same result and further transmitted the infection from monkey to monkey through an indefinite number of passages. Landsteiner and Levaditi[3], in 1909, also transmitted the disease from monkey to monkey and found that the virus remained virulent for some time outside of the body; that the degenerated nerve cells are taken up by phagocytes; and that there is an analogy between the lesions of poliomyelitis and those produced by rabies. They also demonstrated that the virus is filtrable. Leiner and Weisner[4] transmitted the infection from monkey to monkey, and found that young animals were more susceptible to infection than older ones, and that the spinal fluid, blood and spleen were negative. Flexner and Lewis[2] transmitted the disease by inoculating very large amounts into the blood or peritoneal cavity, also by the subcutaneous method, and independently found the virus to be filtrable. Landsteiner and Levaditi[5] found the virus in the salivary glands, and suggested the saliva, moist or dry, as a source of infection. They also found the spinal fluid negative in monkeys dying from artificial infection.

Soon after this, in 1913, Noguchi and Flexner[6] announced that they had obtained cultures in media similar to the medium used by Noguchi in cultivating spirochetes. In such media, in about five days, the pieces of tissue employed become surrounded by an opalescent haze which increases for five days more, and a sediment gradually forms. Giemsa's stain shows the presence of minute globoid bodies (0.15 to 0.13 microm, diam.) in pairs, short chains and masses. Cultures were also obtained from the filtered virus. Monkeys inoculated with these cultures for a variable number of culture generations may die with typical lesions of the disease. The authors consider these bodies the cause of the disease. They further report that the

1—Landsteiner and Popper—Ztschr. f. Immunitätsforsch, 1909, 11, 377.
2—Flexner and Lewis, Jour. Amer. Med. Assoc., 1909, LIII, 1639, 1913 and 2095.
3—Landsteiner and Levaditi, Compt. Rend. Soc. Biol., 1909, LXII, 592.
4—Leiner and Weisner, Wiener Klin. Woch., 1909, XXII, 1698.
5—Landsteiner and Levaditi, Compt. Rend. Soc. de Biol., 1909, LXVII, 787.
6—Flexner and Noguchi, Jour. Exp. Med., 1913, XVIII, 461.

cultures are filtrable through the coarser filters. Levaditi states that he cannot obtain the results of Noguchi, but that he obtains evidence of growth by the living tissue method. Flexner and his co-workers[7] have not shown that their cultures produced immunity. Their chain of evidence, therefore, as to the specificity of their cultures in etiology is incomplete.

Rosenow and his co-workers[8] claim that they have obtained a particularly irregular streptococcus from the central nervous system and the tonsils of all the human and monkey cases examined by them; that they have found it slightly filtrable; and that it produced typical lesions not only in monkeys, but in many other animals. But they have not yet shown that it produced immunity. Rosenow states further that his streptococcus is the same organism as the minute coccoid organism obtained by Noguchi, and he attempts to prove this by morphologic demonstration of the breaking off of minute forms from larger forms. He has not shown, however, that such minute forms remain minute, and that they grow only anaerobically. Neither has he satisfactorily explained why he obtains so many more lesions in different animals with his cultures than with his virus. Furthermore, others have already claimed that the paralyses produced by streptococci in those animals susceptible to the virus (monkeys, and to less extent rabbits) are not accompanied by lesions similar to those produced by the virus.

What Is Known as to the Cause and Transmission of Poliomyelitis—

Summarizing the results obtained from laboratory investigations, the following facts regarding the cause and transmission of the disease may be said to have been practically established:

(1) The specific cause of poliomyelitis is a so-called filtrable virus; i. e., a virus that will pass through the Berkefeld filter, and is invisible under the microscope in some of its forms; "ultra-microscopic" as that term is generally understood. While various micro-organisms have been described and claimed to be the cause of the disease, absolute proof of any one of these being the specific etiological agent is lacking. However, the organism found in cultures of the virus as described by Flexner and Noguchi is clearly seen under microscope.

(2) The virus obtained from human cases of this disease injected into monkeys produces in them characteristic effects almost identical with those produced in man. The only animals, other than monkeys, that are definitely susceptible to the infection are rabbits, but the susceptibility of these animals is highly inconstant, and the effects produced are unlike those produced in monkeys.

(3) The virus has been demonstrated in the tissues and secretions of persons dead of poliomyelitis, namely, in the brain and spinal cord, the mesenteric glands, in the tonsils, and in the mucous secretions of the nasopharynx, the trachea and the intestines; also in the secretions of persons

7—Flexner and Co-workers, Jour. Exp. Med., 1913 and 1914.
8—Rosenow, Towne and Wheeler, Jour. Amer. Med. Assoc., 1916, LXVII, 1202.

acutely ill with poliomyelitis, namely, in the naso-pharyngeal secretions, and in washings from the rectum; also in the naso-pharyngeal and intestinal secretions of persons convalescing from acute attacks of poliomyelitis, and in the naso-pharyngeal secretions of apparently well persons who have been more or less intimately associated with other persons suffering from poliomyelitis.

(4) Outside of the human body, the virus is reported as having been found in nature in the dust of rooms occupied by poliomyelitis patients. The virus has been shown to be very resistant to the influence of low temperatures, certain standard disinfectants (such as carbolic acid) and drying by sunlight, although it is readily killed by high temperatures.

(5) As to the modes by which the virus may enter the human body to cause infection, these can be only inferred from experiments which have been made on animals. Monkeys have been experimentally infected by injection of virus directly into the brain, into the general circulation, into the peritoneal cavity, and even into the skin. They have been infected by rubbing the virus upon the scarified mucous membrane of the nose, and also by rubbing it upon the uninjured mucous membrane. It has also been found possible to produce infection by feeding monkeys through a stomach tube with massive doses of the virus.

Although the results obtained from laboratory experiments concerning natural modes of infections are somewhat inconclusive, they would seem to indicate that the most probable means of transmission of the disease in nature are such as usually serve to transmit secretions from infected persons to the respiratory (or digestive) tract of others, namely, by more or less direct—i. e., direct or indirect, immediate or intermediate—personal contact.

The resistance of the virus to the action of drying and sunlight, together with the fact that dust from a sick room has been found experimentally infective, would suggest the possibility of the infection being spread by dust and fomites, but this has not been positively demonstrated.

It has also been experimentally shown that the infection may be transmitted from monkey to monkey through the agency of a biting fly (the stable fly), and in one instance by the bedbug. These observations would indicate that poliomyelitis may possibly be an insect-borne disease. But isolated cases such as these in animals do not prove that insects play an important part in the transmission of the disease to man.

But by whatever means the virus may be transmitted, having once gained entrance into the body, it circulates with the blood stream and thus produces the disease.

One attack of poliomyelitis apparently confers a high degree of immunity. Recurrent cases and second attacks have been reported.

Original Investigations of the Research Laboratory—

During and since the recent epidemic of poliomyelitis in 1916, original investigations as to the cause and transmission of the disease have been

undertaken by the Research Laboratories of the Department of Health. Fresh material has been available for the following studies:

1st: The infectivity of the spinal fluid from human poliomyelitis.
2d: Characteristics of the virus of the 1916 epidemic in monkeys.
3d: Problems of immunity, active and passive.
4th: Problems of transmission.
5th: Cultural studies on etiology.

Some of this work has been completed, but much of it is still in progress of investigation. The following is the result of the work so far accomplished:

Infectivity of the Spinal Fluid From Human Poliomyelitis—

Repeated attempts have been made to demonstrate the virus of poliomyelitis in the spinal fluid of infected human beings, but so far all have proved negative. Flexner and Lewis* have shown its presence in the spinal fluid from an infected monkey drawn three days after the time of intracerebral injection of virus. This fact would indicate that it is present in the fluid at some stage during the period of incubation. Whether the virus diminishes rapidly, though not wholly disappearing with the onset of symptoms, or whether it is present in the later stages in such minute quantities that it cannot be demonstrated by animal inoculation, it is impossible to say.

In this experiment, undertaken to determine whether or not the aggregate of a number of spinal fluids from positive cases of poliomyelitis contains sufficient virus to infect a monkey, the fluids from forty cases were centrifuged at high speed for three-quarters of an hour. The sediment, amounting to 1 c. c. of very turbid fluid, was injected intracerebrally into Rhesus No. 23. No effects were noted, and after an observation period of two months this animal was inoculated with ½ c. c. of a 10 per cent. suspension of No. VII General Virus. After an incubation period of eleven days, paralysis appeared in the left leg; the paralysis then involved the right leg, but failed to progress further. The animal is alive and improving.

It would appear from the foregoing experiment, therefore, that there is little, if any, infective virus present in fluids of human poliomyelitis.

Poliomyelitis in Monkeys From Virus of the 1916 *Epidemic—*

The first attempts to produce the disease in monkeys resulted in failures. On account of the lack of the supply of fresh monkeys, two animals, both of the Rhesus variety, that had been the property of the Department for several years, were used. These received heavy suspensions of material from the brains and cords of two cases that were clinically and pathologically undoubted cases of acute poliomyelitis. The animals received ½ c. c. of a 20 per cent. saline emulsion intracerebrally, and 2 c. c. of the same suspension, into the tissues around each sciatic nerve. After one month's observation,

* J. A. M. A., April 2, 1910—154, p. 1140.

these inoculations were repeated with glycerinated material of the same cases, but in addition they received 10 c. c. of the virus suspension intraperitoneally. The second inoculations were no more successful than the first. These monkeys (Nos. 98 and 102) later received massive inoculations by three routes, intracerebral, perisciatic and intraperitoneal, of known virulent material from a monkey of the second generation. These, too, proved unsuccessful.

It was decided that these monkeys being refractory to infection would serve better as a source of immune serum for later experiments.

Brain and cord material from three new cases, that were clinically positive cases of acute poliomyelitis, was then inoculated by three routes, intracerebrally, perisciatic, intraperitoneally, into two monkeys from a fresh supply, one being a Rhesus and the other a Sapajou, a South American ring tail monkey. They received ½ c. c., 2 c. c. and 10 c. c. of a 20 per cent suspension of this material, respectively, in the three ways above mentioned.

On the seventh day after inoculation monkey No. 1, the Rhesus, presented tremors of the head and weakness in the left leg. This condition progressed to complete paralysis of the limbs, first left leg, then right leg, left arm, right arm, convulsions and respiratory failure. He died on the third day after the appearance of muscular weakness.

Monkey No. 2, a Sapajou, has exhibited no symptoms at this writing, three and a half months after injection.

Two other animals of this variety were subsequently inoculated with a virulent virus, but these, too, were unsuccessful, confirming the unsuitability of this type of monkey for experimental work in the study of poliomyelitis.

No further difficulty was experienced in passing of virus obtained from monkey No. 1 through a series of 16 monkeys, 14 of the Rhesus variety, and two South American Mangabeys. The virus is now in the eighth generation and exhibits evidence of increasing virulence.

The animals of the second and third generations were inoculated with heavy suspensions of the brain and cord material by the three ways mentioned, but subsequent animals were infected by injection of ½ c. c. of 10 per cent. suspension into the brain. The last two animals received ½ c. c. of 5 per cent. suspension intracerebrally.

The technique followed was that in use at the laboratory for the preparation of anti-rabic treatment. Fresh brain and cord material was weighed and ground up in a sterile mortar and sterile salt solution added to make the desired strength. The intracerebral inoculations were always in the right cerebral hemisphere. The animals were anesthetized, and incision was made in the middle of the scalp over the forward part of the skull. The wound was retracted to the right side and a small trephine opening made with an awl in the right frontal bone one-fourth inch anterior to the coronal suture, and just to the right of the sagittal suture. The suspension was injected very slowly. It is well not to incise the pericranium, for, if intact, it acts as a valve over the site of the trephine opening and prevents the escape of the

injected material. The retracted scalp, when it resumes its normal position, also aids in the prevention of leakage. In performing the peri-sciatic inoculations, care was taken to place the needle in close relation to the posterior aspect of the middle of the femur before expelling the material.

Of the seventeen animals inoculated, all but two (Rhesus No. 50 and No. 51) exhibited frank signs of paralysis. On the fourth day after inoculation, No. 50 became quite subdued and huddled in a corner of the cage. On being forced to move, it was noticed that he limped slightly on the right hind leg. This animal then received two intra-spinal injections of serum obtained from Rhesus No. 102 on successive days. The animal seemed to improve rapidly, and at this date shows no weakness in any muscle. This was the only animal that appeared to limp. Five others, similarly treated, did not show symptoms.

Rhesus No. 51 exhibited symptoms of distress on the fourth day after inoculation, which consisted of tremors and general weakness; he showed no evidence of paralysis in any limb. This general muscular weakness progressed, and the monkey died on the third day after onset of symptoms. The brains showed hyperaemia, and sections of the cord presented redness and swelling of the gray matter. The lungs and other organs were apparently normal. This form of the disease in monkeys has been encountered many times by workers in this field, and has been called the marantic type of monkey poliomyelitis. Subsequent inoculations with material from this animal produced the typical spinal type of paralysis.

The incubation period of this series was from four to thirteen days. Eight (or 47%) developed paralysis on the seventh day, two on the eighth day, two on the fourth day, and one each on the fifth, tenth, eleventh, twelfth and thirteenth days after inoculation.

Twelve of the seventeen animals died (a mortality of 71%). Of the remaining five, four exhibited residual paralysis. The average duration of illness, for eleven of the twelve fatal cases, was four days, the limits being two and seven days. Rhesus No. 25 died twenty days after onset of paralysis. This animal previously had been inoculated with brain and cord material from a rabbit, and exhibited flaccid paralysis of a progressive type. The present inoculation produced no effects, and, after an observation period of six weeks, he was again inoculated along with two other animals, No. 36 and No. 37, with material from No. 26, fourth generation. The incubation period of No. 36 and No. 37 was seven days, that of No. 25 was thirteen days. With the onset of the symptoms, paralysis progressed rapidly for three days. Then the process appeared to subside and the animal improved for a period of nearly two weeks. After this quiescent period, the paralysis began where it left off, and the animal died of respiratory failure on the twentieth day of the disease.

The character of the paralysis in all but two of the animals was that of the progressive spinal type, beginning in the left leg, progressing to the right leg, left arm, right arm, and in the fatal cases to respiratory paralysis. In

one animal, paralysis appeared first of the right leg, then left leg, left arm, right arm, and paralysis of respiration. In the other, the symptom appeared first, in the left arm, right arm, then simultaneously in both legs, and respiratory paralysis. In the non-fatal cases, except No. 5υ, paralysis extended to the left arm, leaving the right arm untouched. With the cessation of the progress of the disease, the left arm recovered its power to some extent, but the paralysis of the legs was permanent.

The gross pathologic changes presented a similar appearance in all the fatal cases, consisting in moderate congestion of the pial vessels of the brain and cord.

Cut sections of the cord at various levels presented a reddening and swelling of the gray matter, rendering it very distinct and prominent.

The microscopic picture presented congestion and edema, some capillary hemorrhage, peri-vascular and also diffuse round cell infiltration, and ganglion cells in various stages of destruction and neurophagia—all the changes present in human cases, except that they are more severe in the experimental animals.

Passage of this virus will be continued with the hope of increasing its virulence, so as to permit us to use filtrates in further work.

Appended is a chronological table of protocols of the animal work here recorded.

CHRONOLOGICAL TABLE OF PROTOCOLS.

No.	Species.	Generation.	Date of Injection.	Incubation.	Amount of Injection.	Site of Injection.	Duration of Disease.	Character of Paralysis.	Outcome.
1	Mac. Rhesus.....	I	Aug. 12, 1916	7 days	½ c.c.—20% 2 c.c.—20% 5 c.c.—20%	Brain..... Perisciatic..... Peritoneum....	3 days	Progressing spinal, beginning in left leg.	Died Aug. 22, 1916.
10	Mac. Rhesus.....	II	Aug. 23, 1916	7 days	½ c.c.—20% 2 c.c.—20% 10 c.c.—20%	Brain..... Sciatic..... Peritoneum....	3 days	Progressing spinal, beginning in left leg.	Died Sept. 1, 1916.
50	Mac. Rhesus.....	III	Sept. 1, 1916	4 days	½ c.c.—10% 2 c.c.—10% 10 c.c.—10%	Brain..... Sciatic..... Peritoneum....	3 days	Slight weakness in left leg.	Recovered without paralysis.
51	Mac. Rhesus.....	III	Sept. 1, 1916	4 days	½ c.c.—10%	Brain.....	3 days	General muscular weakness, Marantic type.	Died Sept. 7, 1916.
24	Mac. Rhesus.....	IV	Sept. 9, 1916	5 days	½ c.c.—10%	Brain.....	4 days	Progressing spinal, beginning in left leg. Cessation process, both legs and left arm involved.	Recovered with residuals.
26	Mac. Rhesus.....	IV	Sept. 21, 1916	7 days	½ c.c.—10% (No. 51)	Brain.....	3 days	Rapidly progressing spinal, beginning with left leg.	Died Oct. 10, 1916.
27	Mac. Rhesus.....	IV	Sept. 21, 1916	7 days	½ c.c.—10% (No. 51)	Brain.....	3 days	Rapidly progressing spinal, beginning with left leg.	Died Oct. 1, 1916.
36	Mac. Rhesus.....	V	Oct. 2, 1916	7 days	½ c.c.—10%	Brain.....	4 days	Rapidly progressing spinal, beginning with left leg.	Died Oct. 12, 1916.
37	Mac. Rhesus.....	V	Oct. 2, 1916	7 days	½ c.c.—10%	Brain.....	5 days	Progressing spinal, beginning with left leg, progressed as far as left arm.	Recovered with residuals.
25	Mac. Rhesus.....	V	Oct. 2, 1916	13 days	½ c.c.—10%	Brain.....	20 days	Slowly progressive spinal, beginning in left leg.	Died Nov. 3, 1916.
42	Giant Mac. Rhesus	VI	Oct. 13, 1916	12 days	½ c.c.—10% 5 c.c.—10%	Brain..... Peritoneum....	7 days	Progressing spinal, left leg.	Died Oct. 31, 1916.
43	Mac. Rhesus.....	VI	Oct. 13, 1916	10 days	½ c.c.—10%	Brain.....	5 days	Progressing spinal, left leg.	Died Oct. 27, 1916.
S	Mac. Rhesus.....	VII	Oct. 31, 1916	8 days	½ c.c.—10% 5 c.c.—10%	Brain..... Peritoneum....	2 days	Progressing spinal, left leg.	Died Nov. 9 1916.
52	Mac Rhesus.....	VII	Nov. 2, 1916	7 day	½ c.c.—10%	Brain.....	5 days	Progressing spinal, left leg.	Died Nov. 13, 1916
53	Mangabey.....	VIII	Nov. 10, 1916	7 days	½ c.c.— 5%	Brain.....	6 days	Progressing spinal, beginning in right leg.	Died Nov. 22, 1916.
54	Mangabey.....	VIII	Nov. 10, 1916	8 days	½ c.c.— 5%	Brain.....	7 days	Progressing spinal left leg, and weakness of right leg and left arm.	Appears to be recovering.
23	Mac. Rhesus.....	VIII	Nov. 15, 1916	11 days	½ c.c.—10%	Brain.....	4 days	Weakness of left and right legs.	Appears to be recovering.

Cultural Studies on Etiology—

Notwithstanding their many experiments, full proof is wanting that the minute organism described by Flexner and Noguchi in 1911* is the specific cause of poliomyelitis. In the first place, they have found their organism in only a small percentage of the cases examined by them, and then in only a few of the many culture tubes examined; secondly, their cultures are filterable with difficulty, while the virus passes finer filters with comparative ease; thirdly, their cultures have not been found to produce antibodies and give no protection in the monkey, while the virus protects in the animal; fourthly, the human virus, through monkey passage, increases in virulence, which has not been shown to be the case with the culture virus.

Considering these and other unsettled points regarding the etiology of this disease, it seemed advisable to plan as full a study as possible of the cause.

Method of Handling Material.

Autopsy Material—

The autopsies were made under as aseptic precautions as possible. Such aseptic conditions were especially satisfactory as carried out in monkeys. The brain, and then the spinal cord were removed and placed in sterile receptacles. In some cases, following Rosenow's method†, before removal of the central nervous system, a portion of the surface was seared and a sterile capillary pipette was inserted, and some of the contents, both the fluid from the ventricles and the nerve tissues from different parts of the interior of the brain and spinal cord, were removed.

The material was brought immediately to the laboratory, and the following culture media were inoculated from different parts, in most cases in the order given:

Veal agar plates with and without 0.2% glucose; extract broth plus 0.2% glucose; veal broth; slant egg medium with and without ascitic fluid; slant Bordet medium with and without ascitic fluid; veal horse serum agar tubes with and without 0.2% glucose; ascitic kidney (prepared as recommended by Noguchi).

Most of the tubes were made with and without albolene, and some were placed in an atmosphere of nitrogen as well. From twenty to two hundred initial cultures were made from each case. The cultures were put in the incubator at about 34° C. After these were made, material was then taken for filtering, some for inoculation of monkeys and rabbits; other material was dropped into fixatives for sections; and still other was put into 50% gylcerine and stored in the ice box at about 7° Co. for later examinations. The remaining material from many of the good autopsies, not used by other workers, were sent sealed to a cold storage plant.

* Flexner and Noguchi, Jour. Exp. Med., 1911 and 1913, VXIII, 461.
† Rosenow, Journal Amer. Med. Assoc.. 1916, LXVII. 1202.

Results from Cultures—

The immediate results of our primary cultures are given in the following table:

Results from Primary Cultures of Fresh Material.

	Smears.			Pure Cultures.		
	Minute Strepto-bacterium Similar to Flexner-Noguchi.	Strepto-coccus.	Other Minute Organisms.	Minute Strepto-bacterium Similar to Flexner-Noguchi.	Strepto-coccus.	Other Minute Organisms.
Human Cases—						
8.....	+	+	+	..	1	4
10.....	+	+	0	2	7	..
4.....	+	0	+	..	..	2
4.....	+	0	0	..	..	..
3.....	—	+	+	..	..	1
2.....	—	+	—	..	..	..
3.....	—	—	+	..	..	1
5.....	—	—	—	..	..	..
Monkeys—						
2.....	+	+	+	..	2	..
2.....	+	—	+	..	..	..
2.....	—	+	+	..	2	..
4.....	—	+	—	..	4	..
		Animal Controls.				
Human—						
1.....	—	—	—	..	..	..
Monkeys—						
1.....	—	+	—	..	1	..
Dogs—						
1.....	—	+	+	..	1	..
Cats—						
1.....	—	—	+	..	..	..
2.....	—	—	—	..	..	..
Rabbits—						
3.....	—	+	—	..	2	..
1.....	—	—	—	..	..	..

The above table gives simply the results from our fresh unfiltered material.

We had forty human autopsies, one of which proved not to be poliomyelitis, so that was put with the controls. Out of the thirty-nine remaining, twenty-six showed in smears a minute strepto-bacterium similar to that obtained by Flexner and Noguchi*, twenty-three showed streptococci, and eighteen showed other minute organisms which are still being studied.

It was comparatively easy to obtain pure cultures of streptococcus from most of those tubes showing them in smears, and pure cultures of the several minute organisms not like the Flexner-Noguchi organism, but owing, apparently to many contaminations, only twice so far have we obtained pure cultures of a micro-organism answering to the organism as described by them.

* Flexner and Noguchi, Jour, Exp. Med., 1913, XVIII, 461.

We fortunately are able to compare these organisms, since we were presented with four strains of the Flexner-Noguchi germ, and they are now being closely studied. So far they seem similar.

Culture Controls—

The largest number of our cultures were made in media to which normal tissues were added, therefore all media had to be most carefully controlled. We found streptococci in our control tubes several times and found even more frequently a small irregular bacillus, with many minute forms, growing rather slowly, so that the early examinations did not show it. Occasionally, whole sets of our animal tissue cultures were contaminated by such small organisms.

Animal Experiments—

One of our strains (P. 7) was inoculated into a monkey on the third culture generation and produced in twenty-four hours a spastic paralysis in the arm opposite the lesion. In forty-eight hours, the leg on the same side as the arm became stiff. Later, after two or three days, the arm became better, but the leg became weak. The leg continued in this condition for several weeks, and is still being slightly dragged. We expect to inoculate this animal later with "fixed monkey virus" to test his immunity. Of course, the third culture generations do not rule out passage of an ultramicroscopic filtrable virus.

In our cultural work so far, we have been much hampered by the lack of monkeys. For this reason we could not test our later culture generations. It has been the same with our streptococci.

None of the three monkeys inoculated with streptococci from these cases, obtained after the method of Rosenow, showed paralysis. Two rabbits out of twelve, inoculated with streptococcus, showed paralysis with localization of streptococci in the central nervous system.

Relation Between the Flexner-Noguchi Organism and Aerobic Streptococci.

Rosenow* claims that his streptococci, developed under anaerobic conditions grow in minute forms similar to the Flexner-Noguchi organism, but he fails to show that his streptococci can be made to grow only anaerobically, as is the case with the Flexner-Noguchi strains.

From our own studies of these streptococci and the Flexner-Noguchi organism obtained by us compared with the strains obtained from the Rockefeller Institute, we must conclude that the Flexner-Noguchi organism is quite distinct from any aerobic streptococcus obtained by us from these cases. Whether or not it is the cause of poliomyelitis we cannot yet say. Many more inoculations must be done before this can be determined.

We have not obtained the Flexner-Noguchi organism so far from any of the filtrates tested.

* Rosenow, Towne and Wheeler, Jour. Amer. Med. Assoc., 1916, LXVII, 1202.

CHAPTER III.

Epidemiology.

Owing to the wide variations observed in different epidemics of poliomyelitis, and on account of the incompleteness of the available data regarding its occurrence and distribution, it is difficult to give in general terms definite characteristics of the disease. Nevertheless, though much remains yet to be learned, many valuable observations have been recorded from experience with past outbreaks, which fairly represent most of the prominent epidemic features of poliomyelitis.

It may be interesting and instructive, therefore, to give a brief introductory historical review of past recorded outbreaks, in relation to their observed epidemiological characteristics, before taking up the study of the epidemiology of the 1916 epidemic in New York City.

Review of Past Epidemics of Poliomyelitis.

Although poliomyelitis has in the last few years assumed a special importance because of its increasing prevalence, particularly in the United States, it is not a new disease. It has been known and described by medical writers and has been appearing in epidemic form, as well as isolated cases, in various parts of the world, for many years.

The earliest notice of the disease is to be found in Scandinavian literature, as given by Underwood in 1784. It was next noted by Badham in 1836, and it is accurately described by Heine in 1840. This latter writer, through his clear presentation of its clinical manifestations at the bedside and the deformities that followed, may be said to have first recognized the disease as an acute spinal paralysis in children. Medin published his celebrated observations on the Stockholm epidemic in 1887. The clinical significance of Medin's work remained almost unappreciated until the accumulated evidence from more recent epidemics emphasized its value. As with many other diseases, the earlier records of poliomyelitis are much obscured by confusion with other maladies, and more especially has it been confused with meningitis.

Prior to 1905, when the first great epidemic occurred, several small groups of diseases were recorded in widely separated localities, as, for instance, that recorded in Louisiana in 1841, and those reported in England in 1843, and in France in 1868, but from the earliest recognition of the affection until recently, Scandinavia has furnished a large majority of the recorded epidemics, and also of isolated cases. The first epidemic of poliomyelitis in Sweden to be recorded was that reported by Bergenholtz in 1881. The most celebrated were those which occurred in 1887 and 1895 in Stockholm, and described by Medin, and the great epidemic of 1905 fully reported by Wickman in Sweden and by Leegaard in Norway.

Accompanying this review will be found in the appendix a table (No. 1) compiled from various sources, which gives in condensed form the date of occurrence, locality, topography and distribution, number of cases, mortality, evidence of infection and transmission, age and sex incidence, etc., together with special annotations and references, of all epidemics recorded previous to 1916.

Observed Epidemic Features.

The following features have been observed in past recorded epidemics of poliomyelitis and are apparently characteristic of the disease:

1. *Seasonal Prevalence—*

Almost without exception the warm season of the year has been reported as the period of the greatest prevalence of the disease. Usually beginning to attract attention in June or July, the apex of the epidemic has been reached in July and August. One great epidemic, namely that occurring in Sweden (1911) had two high periods, one early and the other late in the season, October-December. Some epidemics have begun as early as March or April (Nebraska, 1909, and Iowa, 1910), while others did not get under way until August or September (St. Paul, 1909, and Cincinnati, 1911).

Since the preparation of the report of the New York City epidemic in 1916, the following information has been received through correspondence with Dr. J. B. Weirich, Director, Division of Preventable Diseases, State Department of Health of West Virginia:

> "Between December 10, 1916, and January 13, 1917, an epidemic with 74 cases and 11 deaths occurred in the cities of Elkins, Grafton and Fairmont, and their immediate vicinities, in West Virginia.
>
> "The weather observations for December and January for this vicinity are as follows:

	Maximum, Deg. F.	Minimum, Deg. F.	Mean, Deg. F.
December, 1916	44.3	20.5	32.4
January, 1917	40.0	21.1	32.6."

Complete details, with full epidemiological data, will be found in the forthcoming report of the Director of the Division of Preventable Diseases of the State Department of Health of West Virginia.

Although, as a rule, whenever the disease has been recognized, isolated cases have been reported throughout the year, its epidemic character has almost uniformly disappeared with the approach of cool weather. In none of the epidemics recorded has this fact been satisfactorily explained. In certain epidemics it was thought that a very dry and dusty season was favorable to the spread of the disease, but comparison of meteorological data, during the periods of epidemics in this counrty and abroad, shows

that there is no constant, or apparently any causal, relationship between the dryness or wetness of seasons and the prevalence of the disease either in cities or in rural communities.

2. *Topography—*

Until recent years poliomyelitis was regarded as a rural disease, and the history of early recorded epidemics apparently substantiates this opinion. The Scandinavians, who from long experience with the malady may be supposed to have understood it well, consider it entirely of rural origin. The Royal Institute of Sweden, in a report to the Fifteenth National Congress on Hygiene and Demography, called attention to the "endemic continuance of the diseases in rural rather than in urban districts, while epidemics flare up more markedly in cities."

The following table shows the comparative minor incidence of poliomyelitis in towns in Sweden:

Epidemics in Sweden.

Years	1905	1906	1907	1908	1909	1910	1911
Cases	1016	429	467	317	178	109	3840
Percentage in towns	7%	3%	23%	11%	8%	6%	19%

3. *Distribution—*

Most of the earlier so-called epidemics comprised only a few cases scattered among a comparatively large population. Even in the epidemic of 1905 and 1906 in Norway and Sweden, the largest up to that date, the cases were widely disseminated, although small separate groups often occurred.

The same wide distribution of cases was also evidenced in the epidemic of 1907 in New York City. In Nebraska in 1907 fifty-five per cent. (55%) of the cases developed within two counties containing 31,000 inhabitants, and although there followed other groups in a way to suggest possible sources of infection of one group from the other, it could not be said with any degree of probability that the foci of the disease had a common origin. This was undoubtedly the case in New York City, although an effort was made at the time to hold it responsible for the subsequent Western outbreaks. It is true, in like manner, of the Minnesota and California outbreaks of the same and following years. No other facts were established in the German epidemic of 1909, and in the Washington outbreak of 1910. One important observation, however, has been made from the study of the distribution of cases in various epidemics, such as those in Scandinavia and California, in Massachusetts and elsewhere, namely, that when the disease repeated itself in successive years, the epidemic of the next following year seemed to spare the areas of greatest prevalence of the preceding years.

The almost world-wide extent of the malady is evident from a glance at the accompanying table (appendix Table No. 1), which includes nearly every European country, besides showing epidemics in North and South

America, in Australia, the West Indies and in the South Sea Islands. No portion of the globe has thus been exempt from the disease, except perhaps Asia and Africa, from which no cases have so far been reported.

4. *Number of Cases—*

The cases recorded have usually been so scattered that it seemed futile to attempt to estimate their ratio to the population, but whenever the article consulted gave actual figures, these have been incorporated in the table under " special annotations." The total number of cases reported, however, indicates the constantly increasing prevalence of the disease.

5. *Mortality—*

The death rate for poliomyelitis has varied from very low, in most of the small or isolated epidemics, to from twenty to twenty-five per cent. in the larger epidemics in the United States. Since a greater proportion of the severe cases have evidently been recorded, while many of the milder cases have probably been missed altogether, these figures must be considered as approximate only.

6. *Age Incidence—*

As a rule, the majority of cases in the epidemics recorded have been among infants, ninety per cent. having been under ten years of age. In Norway in 1868 fourteen per cent. were adults. In the Iowa epidemic of 1910, over twelve per cent. of those affected were adults, among whom the death rate was high. In Norway, again, in 1911, the adult case rate was remarkably high, namely twenty-five per cent. of all cases reported. From this it would appear that, although there has been a relatively greater incidence among persons under twenty years of age, and a smaller incidence among the adult population, older children and adults have not always escaped.

7. *Race and Sex—*

No racial susceptibility or immunity to the disease has been recorded, although, in certain epidemics, one or other racial group may have apparently shown at times a somewhat restricted incidence.

As to sex, the proportion of males to females has averaged three to two, in recorded past epidemics; no explanation is given of this discrepancy, but a similar observation as to sex has also been made in other diseases.

8. *Relation to Domestic Animals—*

This factor, so often referred to in the reports, may be summarized by the following quotation from Frost (Hyg. Lab. Bul. No. 90):

> It has frequently been suggested that domestic animals may play an important part in the spread of poliomyelitis. This suggestion is based chiefly upon the observations during epidemics of paralytic affections of various animals: dogs, cats, horses, cattle, swine, rabbits,

and fowls. So far no evidence has been adduced to show that these paralytic affections are etiologically related to human poliomyelitis, and considering that various paralytic affections are rather common, it may well be that the frequency with which such instances have been observed during human epidemics of poliomyelitis is attributable largely to the increased interest which they excite at such times."

9. *Contact Infection—*

Inasmuch as the earlier epidemics were usually small and not well studied, practically the only information available regarding this point is the frequency with which more than one case developed in a family or household. Holt, who searched the literature of thirty-five epidemics occurring prior to 1908, could find but forty such instances comprising ninety-six cases.

Gundrum, in reporting the California epidemics of 1910, 1911 and 1912, found that four per cent., three per cent. and eight per cent. of the respective years might be considered contact cases.

Dixon, in reporting the Pennsylvania epidemic of 1910, comprising 1,076 cases, claimed that six per cent. were contacts.

Harbitz (J. A. M. A., Sept. 7, 1912), says that "the conclusion of the Norwegian physicians is that poliomyelitis is an acute infectious disease which must be considered directly communicable from one person to another." He states that "in the study of virulent house epidemics, it was also found that one member of the family after the other became infected, with a few days intermission, and that they would exhibit the disease in its different forms." He gives several illustrative cases which apparently confirm this statement.

In the English epidemic of 1911, some one in nearly every household in a small hamlet in Devonshire became ill with what seemed to be an abortive attack. Only one or two developed paralysis. In the Massachusetts epidemic of 1908, among sixty-seven families in which single cases occurred, there were one hundred sixty-six children, but only two later or secondary cases. In the Nebraska epidemic (1909), among forty-one families in which there were one hundred fifty-six children, there occurred eighty-six cases. In the Pennsylvania epidemic (1910), two hundred eighty-nine children slept in the same rooms with paralytic cases, but only twenty-four contracted the disease. In the Iowa epidemic (1910), among twelve families comprising seventy persons, and furnishing the entire attendance of a small county school, there occurred only five paralytic and probably eighteen abortive cases.

From an investigation of the Iowa epidemic of 1910, of that in Cincinnati in 1911, and of that in Buffalo in 1912, Frost (Hyg. Lab. Bul. No. 90) found 105 cases (23.17%), giving histories of contact, certain or probable, direct or indirect, with previous paralyzed abortive or indefinite suspected cases, and 348 cases (76.83%), giving no history of any contact with any previous case.

It is evident, therefore, he says, "that contact with previous recognized

or even suspected cases of poliomyelitis was not established in one-fourth of the cases investigated; that while it is true that in the above figures here is probably a cerain error due to failure to elicit histories of contact in some cases where it had actually taken place, it is most probable that any such error would be counterbalanced by the inclusion of some cases in which the history of contact was not altogether evident."

In a study of the contagiousness of the same epidemics, from the point of view of the incidence of the disease among persons known to have had intimate contact with acute cases, Frost states that the apparent contagiousness of poliomyelitis is considerably less than that of diphtheria or scarlet fever, even when clinically doubtful cases are included. Nevertheless, he concludes that none of the factors that are usually considered in the spread of an infection, other than personal contact, seems to offer an adequate explanation of the origin and spread of the epidemic, although further and more clinical study of the disease is undoubtedly essential to a clear understanding of its epidemiology.

10. *Persistence of Infection—*

The Royal Medical Institute of Sweden states that during the great epidemic of 1911, experiments demonstrated that infection persisted in the mouth and in the intestinal tract of some convalescents for long periods of time, namely, from a few (two or three) weeks to several (four to seven) months, after onset of the malady. These experiments were made from both mouth and intestinal washings, and the virulence tested by intra-peritoneal injections in monkeys.

11. *Fomites—*

In connection with the same epidemic, Josefson states that the infection apparently adhered to handkerchiefs and other recently handled articles, and remained virulent for several days.

12. *Food and Milk—*

It does not appear from the records that food has had any definite relation to the spread of the disease. As the result of his study of the Iowa epidemic, Frost states that infection from a common food or water supply could be readily eliminated, as the source of these supplies was so various; that food supplies which ordinarily fall under suspicion, namely, dairy products, fruits and uncooked vegetables, were, in the great majority of cases, obtained by each patient on his own premises; that even staple groceries of the affected families were obtained from various sources; and that the possibility of infection having been contracted and spread through ice cream, soda water, etc., at some common source could also be eliminated.

In the study of various other epidemics, the question as to the milk supply as a possible source of infection has been especially considered, but it was usually agreed that unless a great many different foci of infection

existed the evidence did not seem to point that way. Since the main incidence of the malady has been largely among the milk-fed portion of the community, it is only natural that milk should have been suspected of being in some manner involved, and it was recognized that this food might act in two ways: it might convey infection directly, or it might, during the process of digestion, aid more than any other kind of food in the development of the virus within the body.

In this connection, the question as to the relative prevalence of the disease among nurslings is interesting, since those that contracted poliomyelitis who were fed exclusively upon mothers' milk could be definitely stated not to have received their infection through cow's milk. The records on this point, however, as given in the history of past epidemics, are not sufficient to be of much value. The following include all the data that could be found:

Epidemics.	*Year.*	*Status of Cases Regarding Breast Feeding.*
New York	1907	"121 cases exclusively breast-fed out of 283 infants under 2 years."
Massachusetts	1907	"None of seven cases under 1 year exclusively breast-fed."
Westphal, Germany	1909	"Considerable number of breast-fed children affected."
Massachusetts	1909	"No cases exclusively breast-fed."
Iowa	1910	"Two cases exclusively breast-fed out of 47 studied."
Cincinnati	1911	"15 cases exclusively breast-fed out of 83 studied."
Buffalo	1912	"12 cases exclusively breast-fed out of 40 studied."

13. *Place Infection—*

The widespread distribution of cases would seem to indicate that if place infection, as by means of dust, etc., was operative at all, it must have been through numerous foci having apparently no relation to one another.

14. *Insects as Carriers—*

Although several kinds of insects, *e.g.*, flies, bed bugs, fleas, and the like, have been occasionally suspected of acting as mechanical carriers of poliomyelitis, no particular insect has been positively incriminated. In any event, there has been no indication from the history of past epidemics that insects played any important part in the spread of the disease.

Poliomyelitis in New York State and City in the Past.

There are no available statistics as to the prevalence of poliomyelitis in either the State or City of New York prior to 1907, when the first considerable epidemic occurred. Some indication, however, of the number of sporadic cases is given by the following list* of cases applying to the clinic

* Bogardus, in discussion of paper by Bowden, J. M. S. of N. J.—1908.

of the New York Orthopedic Hospital for treatment of the sequelae of infantile paralysis during the ten years preceding 1907:

Years.	Cases.
1897	79
1898	65
1899	78
1900	56
1901	98
1902	110
1903	108
1904	90
1905	82
1906	106
1907	215

Epidemic of Poliomyelitis in New York City in 1907.

In 1907, New York City suffered an extensive outbreak of poliomyelitis. The statistics of this epidemic are very incomplete. Owing to the inclusion of poliomyelitis in the mortality returns with "other diseases of the nervous system," the exact number of deaths from the malady is not available, and even the number of cases reported as occurring within the city is largely based upon guess work. Whether the infection was directly imported from Europe, as many seem to have thought, or whether it followed the Scandinavian theory of endemic rural foci overflowing into the city, is unknown, and no reliable evidence on the subject is available; but it would appear from the list of cases given above, which occurred annually in New York previous to 1907, that poliomyelitis has long been endemic in the City.

The Committee* which investigated the 1907 outbreak obtained positive information concerning eight hundred (800) cases only, although it was estimated that two thousand five hundred (2,500) cases had occurred. These eight hundred cases were carefully mapped and studied, and the results indicated a distribution approximately proportionate to the density of the population. To this there was one exception, namely, on the lower east side of Manhattan where more cases in proportion occurred than elsewhere. The following list gives the number of cases of poliomyelitis occurring in New York City in 1907 in which details of onset were known:

Month.	Cases.	Month.	Cases.
January	5	July	133
February	3	August	188
March	4	September	218
April	3	October	71
May	10	November	20
June	59	December	4

Total—718 cases.

* The collective investgation committee of the poliomyelitis epidemic of 1907 was composed of representatives of the New York Neurological Society, the Pediatric Section of the New York Academy of Medicine, the Rockefeller Institute of Medical Research, and the Health Department of New York City.

The virulence of this epidemic seems to have been very mild when compared with that manifested in other large groups of cases elsewhere, and this is true even when a comparison is made with urban epidemics only. The Committee estimated the death rate to be five per cent., and when we compare this mortality with that of the usual European epidemics in cities, namely, ten per cent., and consider the mortality reported of the Buffalo outbreak in 1912, twenty-one per cent., together with that recorded in the recent epidemic of 1916, twenty-six plus per cent., we realize how very mild, apparently, was the virulence of the 1907 epidemic.

The age, race and sex incidence of the disease in 1907, was found to correspond with that recorded in most of the epidemics elsewhere, viz., that though no age, sex, or race was exempt, the incidence was greater among young children than other children and adults, and greater among males than females.

From a study of the family incidence of cases, the Committee made the following observations regarding the communicability of the disease:

Out of 2,000 children in seven hundred sixty-two (762) families, who were reported as having been exposed to the infection, eighteen instances were encountered in which two cases occurred in the same family; in two instances three cases occurred in the same family; in very few instances did more than one case occur in a household.

There was no evidence that the schools had anything to do with the spread of the malady, as they were closed during the period of extensive prevalence.

Regarding the incubation period, the results, though not conclusive, indicated that it was, approximately, from three to seven days.

CHAPTER IV.

Epidemiology (Continued).

1. Poliomyelitis in New York City in 1916.

With the hope of solving certain problems which have so far remained doubtful, the Department of Health has made an epidemiological study of the 1916 outbreak. Although the results obtained have been inconclusive regarding some of the points which await complete elucidation, new features of interest have been brought to light during the recent epidemic, while others, partially established, have been positively confirmed. The following data are taken from the official reports and records:

Season—

Deaths from poliomyelitis as recorded each month for the past five years (1912-1916) occurred sporadically throughout each year, but the mortality was highest each year during the months of July, August, September and October—in other words, during the warm season.

From 1912 to 1915, inclusive, there was a gradual decrease in the number of deaths reported from this disease.

In 1916, the mortality averaged the usual rate until June, when it began to rise. This rise continued until the first week in August, when it reached its maximum, and thereafter commenced to decline.

It is to be noted, according to these statistics, that poliomyelitis in New York City is a disease of the warmer months, even when it is not epidemic. (See table II in the appendix.)

Onset—

From May 12, 1916, sporadic cases of poliomyelitis were reported, but not until June did the reported cases become sufficiently numerous to attract attention, and then only in the Borough of Brooklyn. During the succeeding weeks, in this borough, the number of cases reported rose steadily. During June, in the Borough of Manhattan, several cases were reported, but not until the first week of July did the reported cases become sufficiently numerous to warrant the statement that the epidemic had found its way to the most thickly populated borough of the City. During the last few days of June, cases also began to appear in the Boroughs of Queens and Richmond.

On July 11th, in the Borough of Brooklyn, one hundred fifty-one (151) cases were reported, the largest number reported on any one day in this Borough during the epidemic. On or about July 19th, the maximum was reached in the Borough of Richmond; in the Borough of Queens, the crisis of the epidemic was reached on or about August 6th, and in Manhattan and The Bronx, on or about August 12th.

The outstanding fact to be noted from these records is, that during May and the first ten days in June, one hundred eight (108) cases of poliomyelitis had their onset, but only fifteen (15) of these were reported during this period, and four only prior to June 3d. In other words, there were ninety-three (93) foci of infection spreading the disease between May 1st and June 10th, which were not reported and constituted a serious menace to the public, as no measures of isolation were employed. (See table III in the appendix.)

Course—

The course of the epidemic is best shown by a tabulation of cases by week of onset.

Cases of Poliomyelitis by Week of Onset.

Week Ending	Manhattan	The Bronx	Brooklyn	Queens	Richmond	City
June 3.....	5	1	25	1	1	33
June 10.....	8	0	39	0	2	49
June 17.....	6	0	84	1	8	99
June 24.....	17	3	204	4	5	233
July 1.....	50	8	351	8	28	445
July 8.....	118	26	491	52	29	716
July 15.....	119	29	466	99	46	759
July 22.....	192	54	482	117	54	899
July 29.....	305	47	538	145	41	1,076
Aug. 5.....	318	82	573	218	15	1,206
Aug. 12.....	325	90	345	150	25	935
Aug. 19.....	293	85	250	119	12	759
Aug. 26.....	226	52	151	72	4	505
Sept. 2.....	173	61	87	38	8	367
Sept. 9.....	104	34	68	28	4	238
Sept. 16.....	91	35	45	20	0	191
Sept. 23.....	59	30	31	17	2	139
Sept. 30.....	46	23	25	8	3	105
Oct. 7.....	38	27	8	13	0	86
Oct. 14.....	16	8	10	7	0	41
Oct. 21.....	17	7	4	5	0	33
Oct. 28.....	14	2	5	3	0	24
Nov. 4.....	6	4	1	3	0	14
Nov. 11.....	4	0	1	0	0	5
Nov. 18.....	3	1	2	0	0	6

These figures present several interesting epidemiological points. We have, in each of the five boroughs of the city, an example of the typical course of the epidemic covering a period of time from four to six months, the number of cases rising steadily until about the middle period, when it steadily declines.

Under the same conditions of temperature, rainfall, humidity, cloudiness, sunshine, wind, dust, etc., we find the outbreak progressing in one part of the city and subsiding in another.

In the Boroughs of Brooklyn and Queens, the epidemic starting about the same time reaches its maximum in the same week, then begins to decline. In Manhattan and the Bronx, also starting near together, it reaches its maximum in the week following the Brooklyn and Queens maxi-

mum. In the Borough of Richmond, on the other hand, starting later than the others, it reaches its maximum two weeks earlier.

That the course of the epidemic was not materially modified by weather conditions is clearly shown in table IV in the Appendix.

These facts are further confirmed by the following tabulation of fatal cases by weeks of onset of the disease, in the various boroughs and the city:

Deaths from Poliomyelitis by Weeks of Onset of Disease.

Week Ending	Manhattan	The Bronx	Brooklyn	Queens	Richmond	City
June 3.....	1	0	0	0	0	1
June 10.....	0	0	4	0	0	4
June 17.....	0	0	14	0	2	16
June 24.....	7	0	47	0	0	54
July 1.....	9	2	98	4	6	119
July 8.....	18	8	123	17	4	170
July 15.....	30	12	135	28	9	214
July 22.....	60	14	130	37	14	255
July 29.....	85	9	148	41	6	289
Aug. 5.....	92	17	186	74	5	374
Aug. 12.....	103	17	86	40	5	251
Aug. 19.....	88	21	65	31	2	207
Aug. 26.....	69	11	44	20	1	145
Sept. 2.....	38	14	34	10	2	98
Sept. 9.....	35	5	13	8	2	63
Sept. 16.....	23	10	13	5	0	51
Sept. 23.....	21	8	6	8	0	43
Sept. 30.....	12	6	5	4	0	27
Oct. 7.....	9	6	3	4	0	22
Oct. 14.....	4	3	3	1	0	11
Oct. 21.....	4	3	1	0	0	8
Oct. 28.....	5	1	1	1	0	8
Nov. 4.....	2	1	0	1	0	4
Nov. 11.....	1	0	0	0	0	1
Nov. 18.....	..	..	..	..	..	..

Case Fatality—

From the number of cases reported by weeks of onset, and that of deaths by weeks of actual occurrence, it appears that in the fatal cases many deaths did not occur in the first week of the disease, but only after the disease had lasted for several weeks, thus causing an accumulation of deaths reported in the later weeks. This is shown in Table III in the appendix. On hastily glancing at this table, the impression may be conveyed that the case fatality was a steadily increasing one as the epidemic spread, but this is erroneous; the case fatality was more or less a constant quantity throughout the epidemic, as is clearly shown by referring to Table V in the Appendix.

This table (No. V) shows the mortality as it prevailed in over eight thousand eight hundred (8,800) cases followed to their termination; the deaths occurring in these cases being distributed, not according to the weeks

in which the deaths occurred, but by the weeks of onset. The figures for the first three weeks should not be considered, as the cases represented in these weeks are not those that were reported to the Department at the time of their occurrence, but were those that were subsequently found as a result of the investigation made by the Department physicians. As some of the deaths among these cases were attributed to other causes, it is probable that the number of deaths from poliomyelitis, during these weeks, were under-estimated. It is well to know that the deaths as reported in those three weeks numbered only six, and the addition of a few deaths would bring the case fatility, in those weeks, up to a figure comparable with those of the following weeks. It will be noted that, during the weeks from June 24 to October 14, there was no great variation in the case fatality; in most of the weeks the ratios of deaths to cases occurring were approximately 26, 27 or 28 per cent. In only two instances did the rate go as high as 31 per cent. It is evident, therefore, that there was no increasing fatality as the disease progressed, and that a fairly constant ratio between cases and deaths was maintained throughout the epidemic.

The following table shows the duration of the disease before death in 1848 fatal cases occurring before August 31st and made the subject of immediate study:

Deaths of Poliomyelitis by Day of Illness.

Day of Illness.	Deaths.	By Weeks.		Per Cent.
1st	55			
2d	179			
3d	315			
4th	369			
5th	300			
6th	182			
7th	110	1st Week,	1,510	81.7+
8th	67			
9th	41			
10th	36			
11th	28			
12th	16			
13th	15			
14th	8	2d Week,	211	11.4+
15th	11			
16th	15			
17th	8			
18th	6			
19th	5			
20th	10			
21st	5	3d Week,	60	3.2+
Later	67		67	
			1,848	3.6+

The course of the epidemic may also be illustrated graphically by curves, showing the occurrence of cases on day of onset and deaths on

day of death, for the months of July, August, September and October. (See Chart I, frontispiece.)

With the exception of the nurslings, that is children under one year of age in whom death was in no inconsiderable number due to the difficulties of nutrition (partly caused by the muscular paralysis and partly due to the severity of the general infection) almost all of the deaths that occurred in the first week of the disease, and the great majority of those that occurred in the second week, were due to definite and easily observed respiratory paralysis.

From the second week onward, the deaths which occurred were in a progressively smaller proportion of cases, due to respiratory paralysis, and we find in the third week and later, an increasing number of deaths from cardiac failure, from secondary pneumonia and from the late results of complicating gastro-enteritis.

The deaths from cardiac failure in almost all instances followed a prolonged period of persistent rapid pulse rate, the fatal issue following immediately upon what was noted as fibrillation of the heart, with rapidly developing or increasing dyspnœa and cyanosis. It must be left for further clinical and pathological study to determine whether this cardiac failure is due more to myocarditis, originally resulting from the fever and general infection of the disease, or whether, in some instances, it follows a possible late extension of the spinal lesion involving the bulbar centres.

Deaths after the third week were much more commonly due to secondary and complicating broncho-pneumonia or gastro-enteritis, broncho-pneumonia being particularly rapid in its extension and fatal issue in such cases as had extensive primary paralysis of the four extremities, with more or less intercostal paralysis. The clinical pictures presented by those who died with serious nutritional disturbances were similar to those commonly observed in cases of prolonged hydrocephalus and tuberculous meningitis.

Sex and Age—

From a study of the death statistics tabulated according to sex and age, it is evident that the mortality of the disease was heavier among males than females and among young children than older children and adults. A similar preponderance of males over females and young children over older children and adults is found in the incidence of the disease. (See table IV in the appendix, which gives the cases at each age group from June 1st to November 1st, 1916.)

The following additional facts are well shown graphically in the chart (No. 1) attached to the Appendix, namely, that the mortality was greatest in the second year of life; that the mortality of the female was higher than the mortality of the male, in the sixth year of life; that in the second year of life, *i. e.*, between the twelfth and twenty-fourth month, almost 22% of the total number of deaths occurred; that practically 79% of the mortality of poliomyelitis, in this epidemic, occurred in the first five years

of life; and that after the fifth year, there was a steady decline in the mortality of the disease. What has been said as to the mortality of poliomyelitis likewise applies to the incidence of the disease, the greatest number of cases occurring in the second and third years of life. (See able IV in the Appendix.)

The following table gives the results of a study of the ages of 1,325 fatal cases.

Ages in Terms of Percentage.

	Under 1 year	13%
	1+ year	22%
	2+ years	18%
	3+ years	14%
	4+ years	9%
83% were 5 years and under		
	5+ years	7%
	6+ years	5%
	7+ years	3%
	8+ years	2%
	9+ years	1.5%
15% were from 6-16 years		
	10+ years	.75%
	11+ years	.375%
	12+ years	.375%
	13+ years	.75%
	14+ years	.375%
	15+ years	.375%
No. cases under 16 years		97.5%
Over 16 years		2.5%

During the past epidemic, while testing by the Schick reaction the children suffering from poliomyelitis who were admitted to the Willard Parker Hospital, a very interesting fact was established which may have some bearing on the question of natural immunity. Of 1,350 children tested there were between one and four years of age 954, and of these 774, or over 81%, showed a positive Schick reaction. It was very striking indeed to see in the wards row after row of children who gave a positive reaction. At one time, the number of positive tests in this group in the hospital reached between 90 and 95 per cent. In normal children of the same age group, the positive Schick tests vary from 30 to 40 per cent; in measles the percentage of positive tests is somewhat similar; while in scarlet fever it is about 60 to 65 per cent. Considering the relatively mild infectiousness of poliomyelitis (according to Frost 1/15 as infectious as scarlet fever), a fair conclusion to be drawn from these results would seem to be that *a susceptibility to one of the less contagious diseases indicates that the child is also more apt to be susceptible to other contagious and infectious diseases.*

Nationality—

Records have been kept of the deaths from poliomyelitis according to the nationality or nativity of the parents. The number of parents in each nationality was estimated, and the death rate of the children of each nation-

ality was thus computed. It was found that, no nationality was exempt. Only among the children of Austro-Hungarians, Germans, Irish, Italians, Russians, Poles and Americans, was there a sufficient number of deaths recorded to enable a comparison to be drawn between them.

In descending order, the death rate per 1000 estimated population of children under ten years of age, of different nationalities, stands as follows:

United States	3.42
Germany	3.27
Ireland	2.25
Russia and Poland	1.71
Austro-Hungary	1.67
Italy	1.63

From these records it would appear that there was some difference in the fatality of the disease amongst children of different stocks. To what this difference is due it is impossible to say. It is noticeable, however, that the mortality of the Italians, Austro-Hungarians, Russians, and Poles is the lowest. Certainly, the social and economic conditions under which these people live are no more favorable than those under which the Americans, Germans and the Irish live, among whom the mortality of the disease is highest. (See Table XIII in the Appendix.)

As it may be of interest from a sociological, if not an epidemiological, point of view, to know what nationalities were affected, the following list of cases of poliomyelitis is appended. This list is incomplete as to the numerical relation of the different nationalities among the cases of poliomyelitis compared with each other, but it affords a rough guide as to the number of nationalities affected by the disease.

	Manhattan.	Bronx.	Brooklyn.	Queens.	Richmond.	City.
Native (Born in U. S. A.)	822	386	1 873	583	161	3,825
Italian	404	58	684	161	41	1.348
Russian	494	79	685	25	4	1,287
Irish	231	47	277	76	13	644
Austrian	238	27	189	19	6	479
German	82	48	189	144	16	479
Polish	29	9	95	74	17	224
Norwegian	6	..	78	3	14	101
English	21	8	60	21	8	118
Hungarian	60	14	19	10	..	103
Roumanian	24	5	27	1	2	59
Scotch	12	1	27	6	..	46
Swedish	9	3	55	8	..	75
Lithuanian	1	..	13	..	..	14
West Indian	15	..	5	..	..	20
French	6	1	7	3	..	17
Danish	1	1	7	5	..	14
Canadian	10	1	5	3	1	20
Bohemian	12	1	..	5	..	18
Finn	5	5	10	5	1	26
Syrian	1	1	6	1	..	9
Greek	14	..	3	..	..	17

	Manhattan.	Bronx.	Brooklyn.	Queens.	Richmond.	City.
Swiss	7	5	1	1	..	14
Spanish	8	..	4	..	..	12
Dutch	4	..	1	..	..	5
Turkish	8	..	2	..	..	10
Cuban	5	..	1	..	..	6
Japanese	1	..	1	..	..	2
Slavonian	1	..	1	..	..	2
Belgian	1	..	..	..	..	1
Porto Rican	1	..	..	..	..	1
Portuguese	1	..	..	..	..	1
Mexican	1	..	..	..	..	1
African	1	..	..	..	..	1
South American	1	..	..	..	..	1
Indian	1	..	..	..	..	1
Armenian	2	..	..	..	..	2
Ukarainian	..	..	1	..	..	1
Serbian	..	..	..	..	1	1
Total	2,540	700	4,326	1,154	285	9,005

Race—

Records were also kept of the incidence and mortality of poliomyelitis among different races. Only among the negro race were there a sufficient number of cases and deaths reported to be able to compare them with the white race; and these are too few to draw any conclusions from them.

In comparing the incidence of poliomyelitis among whites with the incidence among negroes, it will appear that the negro is less susceptible to the disease than the white, but when the mortality of both races is examined, the reverse seems to be true; in other words the general mortality and case fatality rates are higher for the negroes than for the whites. The reason for this apparent anomaly cannot be positively stated, but it is probable that all cases of the disease among the negroes were not detected, while deaths had to be reported before the bodies could be buried. A plausible explanation may possibly thus be found for the apparently low incident rate and high mortality rate among negroes. (See table VII in the Appendix.)

Incidence and Mortality—

From June 1st to November 1st, during which time the epidemic lasted, there were reported in Greater New York eight thousand nine hundred twenty-eight (8,928) cases of poliomyelitis, with two thousand four hundred and seven (2,407) deaths, giving a case mortality rate of 26.96 per cent. for the period mentioned. These figures, taken from the official records of the Health Department, show a greater case incidence and mortality from the disease than has heretofore been recorded in any previous epidemic of poliomyelitis. The complete figures are given below:

POLIOMYELITIS.

June 1st to Nov. 1st, 1916.

Reported Cases and Deaths—Rate per 1,000 Estimated Population.

Borough	Population	Cases	Deaths	Case Rate Per 1,000 Population	Death Rate Per 1,000 Population	Case Fatality
Manhattan	2,634,223	2,483	706	.94	.27	28.43
The Bronx	575,877	668	167	1.16	.29	25.00
Brooklyn	1,928,432	4,312	1,147	2.24	.59	26.60
Queens	366,426	1,179	330	3.22	.90	27.99
Richmond	97,883	286	57	2.92	.58	19.93
CITY	5,602,841	8,928	2,407	1.59	.43	26.96

Urban and Rural Incidence—

The belief expressed in the past, especially by Swedish authorities, that the incidence of epidemic poliomyelitis is greater in rural than in urban communities, seems to have proved true in the recent epidemic in New York. Within the limits of the City there exist extreme examples of urban and rural conditions. Thus, the highest incidence in proportion to the population has been in those sections of the City which are the least densely populated. For instance, the Boroughs of Queens and Richmond show case rates of 3.22 and 2.92 respectively, as compared to the Borough of Brooklyn with a case rate of 2.24, the Borough of The Bronx, with a case rate of 1.16, and the Borough of Manhattan with a case rate of .94 per 1000 estimated population. The total case rate for the City of Greater New York was 1.59.

Density of Population—City of New York.

Census of 1910.

Borough	Number of Persons Per Acre
Manhattan	176
The Bronx	16
Brooklyn	42
Queens	3.5
Richmond	2.3

Contacts—

A considerable amount of work has been done by the Department in an effort to trace possible contacts with other cases of the disease, as an explanation of the source of infection. Notwithstanding the obvious difficulty attending the conduct of such an investigation, *e. g.*, in eliciting histories, etc., quite a large number of cases have been found which unquestionably had been in close association with previous cases, either of readily recognizable cases of poliomyelitis or ill-defined but suspected cases of the disease. In all such investigations, of course, the possible existence of non-paralytic or abortive cases and healthy carriers as conveyors of infection must be borne in mind. In this research, the positive far exceeded the negative findings in importance from an epidemiological point of view.

As an illustration of the probable contact relation between cases, reproductions of a series of pin or spot maps from photographs are herewith attached, giving the location of each case during the epidemic. Throughout the epidemic these pin maps were prepared for each borough of the city from day to day as the cases were reported. Such maps show, in a striking way, the general extent of the epidemic, and the distribution of the cases in the various boroughs of the city. The special serial pin maps (16) of the Borough of Brooklyn by weeks of onset of the disease, from May to September 16, 1916, show the development of the epidemic in this Borough, and are particularly striking. The grouping of cases is at least suggestive of probable contact infections. (See Maps in the Appendix.)

The special investigation of this subject was the main object of the staff supported by the Rockefeller Foundation. The report of the Director, Dr. A. H. Doty, as approved by the Committee in charge has been summarized as follows:

Scope of the Co-operative Work.

"The starting point of the co-operative work of the Committee, which was carried out by a field force of physicians and nurses under the supervision of the Medical Director, was the belief that mild cases of poliomyelitis were escaping early detection and hence constituted a source of infection not being brought under prompt sanitary control.

"While this was the original and remained the main object of the work of the organization created by the Mayor's Committee and supported by the Rockefeller Foundation, the investigations of the field force extended beyond this purpose. The next or subsidiary undertaking was the collection of data bearing on such questions as the source of infection in poliomyelitis, the incubation period of the disease, the discovery and report to the Department of Health of infractions of the sanitary regulations and other germane matters coming under the personal observation of the visiting doctors and nurses.

"The plan of work was to follow the cases reported to the Medical Director daily by the Department of Health to their homes and then, after obtaining a list of relatives, friends and acquaintances, to go to their abodes in order to ascertain whether cases definitely poliomyelitis or of cases of undiagnosed illness occurred among them. When any were discovered they were reported to the Department of Health whose inspectorial staff took charge and became responsible for subsequent action in connection with the cases. Twenty cases of poliomyelitis which had not previously been reported to the Department of Health were detected in their early beginnings in this way, and reported.

"The Department of Health afforded the most cordial and helpful assistance to the field force of the Committee. It provided also adequate quarters to the Medical Director and his staff in the building of the Department in Brooklyn and supplied a daily list of reported cases on the basis of which the visits were made. I desire, therefore,

to express for myself, my working staff, and the Committee, sincere appreciation of the efficient and courteous assistance rendered by the officials of the Department.

"As will be patent from the statement regarding the main objects of the work of the special committee, the visits of inquiry of nurses and physicians often carried them far away from the case from which the investigation started. The following of the clues thus indicated, provided the chief material on which the essential portion of this report—namely, the evidence for personal contact as the source of infection—is based. In every instance decision as to whether a given case of illness believed to be poliomyelitis was actually such a case was determined by a representative of the Department of Health, whose records have been taken as final. In certain instances, however, the evidence is less perfect. When, for example, the clues led to previous cases of illness which occurred some time prior to the onset or report of the recent cases from which the investigation started, it became necessary to accept descriptions which could not always be verified by an examination of the children who had been ill. But even here the existence of paralysis or occurrence of death, preceded by paralysis of the respiratory function, made the diagnosis of poliomyelitis a reasonable one. It was only in dealing with presumptive instances of the mild or ambulatory form of poliomyelitis to which the name "abortive" is applied, that real doubt entered into the decision. But as care is taken in this report to indicate all such doubtful examples, no serious error has, it is believed, been introduced into the observations.

"As will be noted, the actual work in the field began on July 17th and terminated on September 20th, covering, therefore, a space of about two months.

Analysis of the Data.

"*Number of cases visited.* This report is based upon a study of 5,496* cases declared by the Department of Health to be cases of poliomyelitis visited by members of the field force of the special committee. The records were carefully verified by hospital reports so that it is safe to say that errors in diagnosis have been excluded as far as they possibly could be. While it would be going too far to say that no error could have crept in, it is fair to state that in the opinion of the Medical Director they may be regarded as at most so few as to be negligible.

"A discrepancy exists among some of the figures given in the table and which arises from the fact that the totals do not always agree with the full number of cases—5,496—investigated. The divergencies represent the number in which information was either not available at all, or not regarded as sufficiently authentic to be considered and entered.

"Obviously statements obtained from members of a family regarding previous illness, contacts with other persons, and on many other topics which come up in an epidemiological investigation, must always be confirmed in order to be of value. In the course of our

* The total number of cases occurring in the greater city during 1916 is given by the Department of Health as 9,023.

field studies we had to deal with much loose or worthless testimony of this sort. As far as possible, we avoided falling into errors from this source.

Sources of Infection.

"This subject was kept in the foreground of the investigation because upon it depends efficiency of sanitary measures of control of the epidemic.

"At first thought, it might seem that the very large amount of material available during the recent epidemic would facilitate the task of determining the source of infection in poliomyelitis. Yet, it was just the great number of cases scattered throughout a large and densely populated city which tended to make this inquiry far more difficult than it would have been in a small and sparsely settled community containing few and often widely separated cases.

"A word about the procedures which were regularly followed: In obtaining evidence regarding the presumed source of infection in given instances, not only was proof required that direct association was present but also means were taken to develop and exclude other possible sources of infection.

"In the first instance the original cases investigated and the ones declared to be the source of infection were declared to be true cases of poliomyelitis officially reported to us by the Department of Health. This original diagnosis was, moreover, verified later from the hospital records. In the next place, satisfactory evidence of association or contact between the affected persons and under conditions likely to transmit infection was demanded, as was the establishment of a proper or probable period of incubation.

"The following of this rule excludes a considerable group of cases in which the evidence of the source of infection is good enough to be probable, but not complete enough to be acceptable. We sought not so much quantity as quality of evidence bearing on this all-important question of the source of infection.

"Five hundred and ninety-nine of the cases of poliomyelitis investigated by us, or something over 10 per cent. of the total number we visited, furnished evidence in accord with the rule laid down, which we regard as reliable and thus as conclusive as the source of infection being of the nature of personal contact. In passing, it will be proper at this point to state that our investigation of the epidemic at New Rochelle, embracing 125 cases, gave personal contact as the source of infection in about 30 per cent. of the instances.

"It is not our intention, in this report, to discuss the general evidences presented for and against the notion of personal contact as the source of infection in epidemic poliomyelitis; our purpose is merely to present the facts as found by us and then to draw the conclusions which they seem to warrant. But as the arguments sometimes tend to mislead because they are not based on accurate data, we will first give them and then make comments which may help to clarify the subject.

"For example, it is frequently stated that it is rare for more than one child in a family to be attacked, thereby implying that the infection is not communicated by personal contact. Obviously, before this argument can become valid, the facts themselves on which it is

based must be established and we must also have accurate information concerning the number of children in the families of the affected.

"Our tabulation has been prepared from this point of view. It may be said to show that in far the greater number of instances in which one child was attacked in a family, the family contained one or two children residing at home; and that as the number of children increased per family, the instances of single cases diminished.

"Moreover, the instances of two children attacked in a given family are not as small as usually intimated; while, as will be observed, 13 families had 3 children, 2 families 4, and 2 families 5 children affected (Department of Health does not confirm 5 cases in a family). In all the tabulations given, account has been taken only of the number of children residing at home or directly exposed to infection.

"A special study was made of a group of 250 cases in families in which more than a single child was attacked. No instance was encountered in which the first child affected was less than six months old. However, at one year of age, when a child is able to move about of its own volition and is left at times on stoops and doorsteps to play, through which greater exposure occurs and hence opportunity for infection increases, our records show that fifteen children of this age group were the first in the family to develop poliomyelitis. At the next age period, namely two years, when the child is still more active and independent, 49 children were the first to be taken ill in family, while at three years of age the number first affected has increased to 60.

"Hence, these examples would seem to indicate that the danger of infection increases with and depends largely on more frequent contact of one child with another. Of course, in the case of very young and nursing children the movements of the mother or nurse may be decisive. For example, such a young child brought into a house in which a case of poliomyelitis exists or being fondled by a "carrier" or ambulant case of the disease will, of course, be directly subjected to infection by contact.

"It will be of interest, at this point, to introduce a few illustrative examples of transmission of poliomyelitis, both within the family and from one family to another.

"*Example* 1. Family consisting of father, mother and five children, residing in a particularly well-appointed dwelling house within spacious grounds in Greater New York.

"On July 3, a daughter nine years of age stated that she felt ill; first visited by a physician on July 9. Paralysis occurred on July 12.

"On July 5, a daughter aged three years became ill.

"On July 14, a son aged five and a half years became ill.

"On July 17, the remaining child, a baby nine months old, was attacked.

"All the children were officially declared to have poliomyelitis except the patient taken ill on July 5, in which instance a definite diagnosis was not made, although it is quite probable that this was an abortive case.

"In this instance we may note that although the family at first declared that the children had not been in direct or indirect contact

with a case of poliomyelitis and could not have become infected by exposure, yet a minute investigation disclosed the fact that opportunity for such exposure actually existed. It is not uncommon to meet with misleading statements of this kind which can often be set aside but only after painstaking inquiry.

"*Example* 2. Family consisting of father, mother and eight children, residing in a dwelling house in Greater New York surrounded by large and well-appointed grounds.

"On August 18, a daughter aged nine years became ill.

"On August 21, a son twelve years became ill.

"On August 23, a daughter aged four years become ill; died August 25.

"On August 25, a daughter aged six years became ill; died August 26.

"On August 30, a son aged seven years became ill.

"All these cases were officially declared to be poliomyelitis.

"*Example* 3. Family consisting of father, mother and four children, residing in a tenement house in Greater New York.

"On July 28, a daughter aged five became ill.

"On August 1, a daughter aged seven became ill.

"On August 3, two baby girls (twins) aged one year became ill.

"Three of these cases were officially declared to be poliomyelitis; the daughters, aged five and seven, and one of the twins. No diagnosis was made in the case of the remaining twin, so that doubt remains whether or not this was an abortive case of the disease.

"*Example* 4. Family consisting of father, mother and four children, residing in a private dwelling in Greater New York.

"On August 2, a daughter aged one and a half years became ill; died at home.

"On August 5, a son aged five years became ill.

"On August 7, a daughter aged nine years became ill.

"On August 10, a daughter aged seven years became ill; died in hospital.

"These cases were all officially declared to be poliomyelitis.

"*Example* 5. Family consisting of father, mother and five children, residing in a private dwelling in Greater New York.

"On July 12, the mother, thirty years of age, became ill. She did not seek medical advice until July 17, five days afterward, when her son, aged three and a half years. was taken ill with similar symptoms. A physician was called and subsequently a Department of Health official, who declared both cases to be poliomyelitis. They were removed to a hospital for treatment.

"*Example* 6. Family consisting of father, mother and four children, residing in Greater New York.

"On July 24, a son aged eight years of age became ill.

"On July 27, a son aged three years became ill.

"On July 29, a daughter aged six years became ill.

"These cases were all officially declared to be poliomyelitis.

"*Example* 7. This example shows infection transmitted from one family to another, both families residing in tenement houses. In one of these, a family consisting of father, mother and three

children, a girl five years old was taken ill on August 18. On the following day she was examined by a Department of Health official and declared to be a case of poliomyelitis; removed to a hospital. August 23 a brother, aged three years, was taken ill, and on the following day, August 24, the case was also officially declared to be poliomyelitis, and the boy was removed to the hospital.

"On August 18, a boy five years of age, the son of a neighbor, visited the above family and was with the child five years of age, who was taken ill that day, and was beside the couch when she vomited. Four days afterward, August 22, this boy was also taken ill and was under the care of a private physician who, on August 27, notified the Department of Health that the child had poliomyelitis. The patient died on the same day.

"*Example* 8. Family consisting of father, mother and three children, residing in a private dwelling in Greater New York.

"On August 12, a son aged two years became ill.

"On August 13, the twin brother of the above child became ill.

"On August 15, a daughter five years of age became ill.

"These cases were officially declared to be poliomyelitis.

"*Example* 9. Father, mother and two children, residing in a private dwelling in Greater New York.

"On August 9, a boy of this family, three years of age, was associated closely with the child of a neighbor, a girl two years old, who was visiting at the boy's house. While there the girl was taken sick and vomited and returned home but was not attended by a physician until August 14. The case was officially declared poliomyelitis and was removed to a hospital on August 22.

"The boy, exposed on August 9, was taken ill three days afterward, August 12, and died on August 14. This case was also officially declared poliomyelitis.

"*Example* 10. Father, mother and four children, residing in private dwelling in Greater New York.

"On August 10, a son, aged two years, was taken ill; no physician in attendance. In a few days the child apparently recovered, but again became ill on August 24 with convulsions and died on August 26.

"On August 19, a son aged six years was taken ill. He was treated by a private physician, who, the mother states, did not diagnose the case.

"On August 22, a daughter aged four years became ill.

"On August 23, a son three years of age became ill.

"The child who died on August 26 was declared to be a case of poliomyelitis. No definite diagnosis was made in the remaining cases, although there is reason to believe that they were instances of the abortive type of the disease.

"*Example* 11. Family consisting of father, mother and three children.

"During the latter part of June the mother, forty years of age, was taken ill with headache, fever and vomiting. This continued for a number of days. The case was not under medical treatment.

"About July 15 a son aged three and a half years was taken ill. A physician was called and treated the case as a bilious attack. The child recovered.

"A few days later a son aged two and a half years was seized in a similar way and was treated for indigestion. He also recovered in a few days.

"On August 19 another son, aged six years, became ill and was also treated for indigestion. Twelve days afterward this case was diagnosed as poliomyelitis by the Department of Health official. It is, of course, not established, but it nevertheless seems very probable that this example represents a series of successive cases of poliomyelitis.

"*Example* 12. Family consisting of father, mother and three children.

"On May 20 the mother came from Staten Island to Brooklyn to find a living apartment and visited a number of places for this purpose. She visited one apartment in which a child was ill, although there was no intimation that the patient had an infectious disease. A few days later the mother was taken ill with symptoms suggestive of poliomyelitis, but had no medical attendance.

"On June 15, a daughter aged nineteen months was taken ill and became paralyzed in both legs.

"On June 19, a daughter aged six was taken ill.

"On June 25, a son four years of age was also taken ill.

"Two of these children were declared to be cases of poliomyelitis by the Department of Health and removed to the hospital on July 5th. A subsequent examination of the mother showed weakness of certain muscles of the arm.

"The examples cited indicate, so far as that subject will be considered now, that the onset of the second case in a family was usually three days or longer after the first person fell ill. Probably, therefore, the incubation period is never or at least rarely shorter than that. Since of two persons exposed at the same time, one may fall ill a day or two earlier than the other, instances of apparently very brief incubation period may be merely examples of delayed onset from a previous exposure.

Period at Which Isolation Took Place.

"In endeavoring to limit the spread of an infectious and communicable disease through measures of isolation, the time period becomes an important factor. Were every case subject to prompt isolation, much more would be accomplished. Very often delays occur of which, in respect to poliomyelitis, some are unavoidable. In regard to the 5,496 cases investigated by us, the average interval between the time of onset of the first symptoms and the date upon which the cases came under the observation of the Department of Health was five and one-half days. The interval was longest at the outset of the epidemic and was shortened as the profession of the City became more aroused and more experienced in detecting or suspecting the rather indefinite symptoms with which many cases begin. Sometimes, also, and indeed among the poorer people commonly, no physician is called in for several days. Since not a few cases of the abortive disease never develop severe illness and recover completely in a few days, they may never come under medical attention at all and of course are never isolated.

"Another source and cause of delay in isolation is found in mistaken diagnosis. As just indicated, the symptoms at the beginning may

be quite misleading. Of our series of cases, 941 were first erroneously diagnosed by the attending physician. Subsequently he would sometimes correct the diagnosis himself; at others the Department diagnostician made the correction. In the interval there was, of course, no isolation whatever practiced. About half of the cases erroneously diagnosed were considered as forms of gastro-intestinal disturbance, about 10 per cent. cases of pneumonia, and about 3 per cent. cases of meningitis. In considering this aspect of the subject, the attending physician cannot be charged with carelessness, since until recently he had almost no opportunity to become acquainted with poliomyelitis in its milder and atypical forms especially, which only lately have been more and more emphasized.

NON-PARALYTIC (OR ABORTIVE) POLIOMYELITIS.

"A special inquiry was directed to this class of cases because of their important bearing on the spread of the disease. Many of the cases do not come under medical supervision at all and hence escape all control, and they act as active agents for the further distribution of the infection. Two groups of cases—one of 509 and the other of 469—came under consideration.

"The former group relates to persons taken ill just preceding or immediately following officially reported cases of poliomyelitis with which they had been in contact. Some were, others were not, attended by physicians; in some instances slight paralysis occurred. The history of this group of cases was obtained by the visiting nurses, although the actual illness could not be verified; and the history of the instances in which the illness followed officially declared cases was not obtained until the second visit of the nurse, made a month or more afterwards.

"It can be surmised only that part of these cases were instances of poliomyelitis; but the symptoms described were often very suspicious—which, taken together with the fact that exposures had actually occurred, insures that a percentage were true mild or abortive cases.

"This conclusion is in a measure confirmed by a consideration of the second group of persons, consisting of 469 cases, ill at the time the district nurse visited the premises. Many of these persons were only little ill, and had no medical attendance whatever. Each case was none the less reported to the Department of Health, whose official records show that about 25 per cent. proved to be cases of poliomyelitis.

"We encountered various instances in which evidence pointed to mild, abortive, or unrecognized cases as being the immediate forerunner of marked and obvious cases of poliomyelitis. An example will be given.

> "'Five families residing in adjacent houses in Greater New York were closely affiliated in a social way. Three of the families each had one child; one family had three children, and the remaining family two children. The children were taken daily by their mothers to a nearby park, where they played together while their mothers sewed.
>
> "'About June 30 one of these children became ill, with vomiting, diarrhœa, fever, and headache. The family physician

was called and pronounced the case not serious—only a gastro-intestinal attack—and recommended that the child be kept in bed for a day or so and then allowed to get up. At the end of this period the mother found that the child moved with difficulty, as its legs were stiff. The attending physician was again called and stated that this condition amounted to nothing and would disappear within a few days, which it did.

"'On July 5 a child belonging to another family of this group also became ill. In this instance the symptoms of poliomyelitis were well marked and the family physician notified the Department of Health. The child was visited by a health official, declared to be a case of poliomyelitis, and removed to a hospital.

"'Evidently the circumstances relating to the illness of the child first affected were not officially reported. When the second case was announced, the mothers whose children were not ill promptly left New York with their families and went to a boarding house in an adjoining State to escape infection. Before July 10, all the children of this group were attacked with poliomyelitis. One died, and evidences of paralysis appeared among the others. Although the report of this occurrence obtained from the families of this group bore every evidence of veracity, it was deemed important that it should be properly verified. Therefore, the health officer of the township where the boarding house was situated was communicated with. He confirmed the statement already made, declaring that in his opinion all of the children had had poliomyelitis.'

"The example clearly shows that the first child affected was an abortive or unrecognized case of poliomyelitis, and was the source of infection to the other.

"Finally and in this connection a word may be added on the subject of the healthy carrier of the infectious agent of poliomyelitis. Our study, because of its nature, could not take cognizance of this factor, except to the extent of excluding it when possible by obtaining evidence or indication, in cases of suspect carrier infection, that contact with an actual case of the disease had taken place. We have no figures to present on this very difficult topic; but we believe that the more incisively the matter is investigated, the greater will the actual number of contacts with actual cases be found to be.

Incubation Period.

"To establish a determined period of incubation during an extended outbreak of such an infectious disease as the one we are considering in a thickly populated city, in which infection is widespread and cases are continually occurring, involves difficulties and uncertainties which seriously affect the validity of the result achieved.

"It is, of course, far easier to establish an apparent period of incubation. In sparsely settled communities the former is often capable of accurate estimation; in thickly populated communities, the latter has always to be dealt with. Thus the period of incubation in connection with a group of infected persons in which more or less continuous association is going on cannot be accurately fixed. On

the other hand, when one child in a family falls ill of poliomyelitis and a second child develops the disease six days later, the incubation period is usually put at six days. And yet, as we cannot ascertain the precise moment of infection, it may actually be less than that period.

"The other extreme is that in which a second or subsequent case of poliomyelitis appears within a day or two of the first, suggesting coincident infection, which is what it probably is. And yet, even this involves an assumption regarding the incubation period which may be incorrect. Instances of so-called determined incubation periods, as brief as two days, have been given by certain authors; they arouse, however, grave suspicion as to their validity.

"In our tabulation we have tried to distinguish between the apparent and determined incubation periods; 584 cases fall into the first and 15 into the second category. It is interesting to observe that one-third of the latter fall on the third day and two-thirds within eight days. But a greater number of instances of "determined" incubation periods must be assembled before we shall know whether the figures obtained in our investigation represent the true periods.

"No further comments on the apparent period are perhaps called for. The large number of instances following in the first three days is noteworthy, but cannot be regarded as in the nature of conclusive testimony in favor of a very short incubation period. In other words, the question is left by our study approximately where it was, the critical time falling within the first seven or eight days of exposure.

"It has occurred that a period of two or three weeks has elapsed, or seems to have elapsed, between the onset of a first and second case in a family. The question arising is whether the long period is to be regarded strictly as incubation time or whether the association may not have existed for several days before actual communication of the infectious agent took place. Of the two alternative possibilities, the second seems more likely.

Summary.

"The investigation carried out by the field force of your committee, under my direction, has supplied information of two kinds:

"First, information of practical daily import was obtained by the physicians and nurses who visited premises in which cases of poliomyelitis occurred and the relatives and friends of the affected families, which was turned over immediately to the Department of Health for its use and guidance.

"Second, the data thus collected and recorded were subsequently collated and analyzed in the hope that light might be thrown on the important questions of source of infection, period of incubation, types of disease, significance of food, of diseases among domestic animals, insects, and some other subsidiary topics.

"This second line of inquiry yielded information which led us to regard the disease as one (*a*) communicated by personal contact, (*b*) in which the slight and abortive cases are the most frequent sources of the contagion, and (*c*) in which the incubation period varies between three and ten days. We were not able to make a study of the question of the healthy carrier, but we think it probable that

he plays a less conspicuous part in disseminating the infection than does the mild and often unrecognized case of the disease.

"We gave especial attention to the working out of the incubation period on the basis of the data collected. Recognizing the difficulties and fallacies of the undertaking in a large, miscellaneous population, such as exists in Greater New York, we cannot assert that our conclusion is absolute. We think it probable, however, that taken together with the conclusions of previous investigators, it is virtually correct.

"We could, finally, find no substantial evidence to support the notion of food, lower animal or insect carriage of the infection, although in regard to those subjects our investigations were incidental rather than essential."

Multiple Cases—

In order to determine the frequency with which more than one case occurred in a household, a special investigation was made of multiple cases in families. Out of the total number of cases for the year 1916, 8,635 families were involved.

Multiple Cases of Poliomyelitis in Families.

Number of Cases in Family	Manhattan	Bronx	Brooklyn	Queens	Richmond	City
Two	65	13	159	61	15	313
Three ...	5	1	20	1	1	28
Four	1	0	3	1	1	6
Totals .	71	14	182	63	17	347

(1) 8287, or 96%, had one case only. Total children in these families were 24,883.

(2) 313, or 3.6% had two cases; 28, or .3+%, had three cases; 6 or .06+% had four cases. Total children in these three groups of families were 1,516. Total cases 736.

Thus, multiple cases occurred in only 4% of the families involved—while in the first group, we find that over 16,500 children, intimately exposed to the infection, did not contract the disease.

The investigation showed that, in nearly all instances where more than one case occurred in a family, the onsets were so close as to suggest simultaneous infection. Some cases were found to have been attacked with the disease at a later date, indicating that they were probably secondary infections, but such cases decreased in number, as a rule, with increasing length of time from the first case. Very exceptionally were secondary cases separated from the primary case by a longer interval than two weeks. Similar results were obtained in the study of multiple cases in one house; the majority of the cases would appear to have had a simultaneous infection.

In a study of forty cases, where more than one case occurred in a family,

10 cases	occurred	1 day	from primary case
2 "	"	2 days	" " "
3 "	"	3 "	" " "
1 case	"	4 "	" " "
3 cases	"	5 "	" " "
3 "	"	6 "	" " "
2 "	"	7 "	" " "
1 case	"	10 "	" " "
1 "	"	13 "	" " "

734 cases were reported with an onset of five days or less. As the diagnosis of poliomyelitis was held in abeyance by many private physicians until evidence of impairment of muscular function was apparent, this is also of value in showing the early occurrence of paralysis.

Of 1,500 of the total cases in which the matter of previous exposure was studied in detail by a representative of the Department of Health, it was found that in 29 cases there had been direct exposure to another case in the same family; in 25 instances the fatal case had been exposed to cases out of the family; in 13 cases a member of the family had visited active cases of poliomyelitis within a week of the onset of the disease in the fatal case.

The exact date of first exposure as related to the date of first observation of symptoms in the fatal cases could not be learned, so that any positive conclusion as to whether the cases above recorded were secondary in the accurate epidemiological sense of the word, or merely subsequent and arising from quite other and common source of infection, cannot be offered.

Regarding the degree of contagiousness of this disease, an interesting comparison may be made of the incidence of diphtheria, scarlet fever and measles, in a crowded area of the city, during their period of greater activity, with the recent incidence of poliomyelitis in the same section.

In both scarlet fever and diphtheria we recognize considerable natural immunity. Further, in diphtheria an immunity is commonly conferred by artificial passive immunization of exposed persons.

The area selected for this comparison was the congested "East Side" of Manhattan, a district lying between Broadway and East Third Street to East River, known as the Corlears District, having a total population of about 430,000 persons.

Comparison of Incidence of Contagious Disease, Corlears District.

	January	February	March	April	May
Diphtheria	132	103	122	123	139
Scarlet Fever	41	36	35	59	66
Measles	25	58	186	287	288
	June	July	August	Sept.	Oct.
Poliomyelitis	13	189	154	20	4

These figures would seem to indicate that poliomyelitis is certainly no more readily communicable than are diphtheria, scarlet fever and measles, and one might fairly conclude that with immunity to this disease as evident as that recognized in the other so-called "contagious diseases," in a fixed population, its communicability is decidedly less.

Overcrowding—

In order to determine whether there was any relation between congestion and the spread of the disease, the following summary of data collected by the Tenement House Department is interesting:

In the Borough of Manhattan, out of 614 cases of poliomyelitis occurring in tenements, the largest number of cases, 152 to the tenement, occurred in tenements of eighteen apartments; quite a large number of cases occurred in tenements of three to ten apartments, but the smallest number of cases occurred in tenements of thirty to ninety apartments to the tenement. In the Boroughs of The Bronx, Brooklyn, Queens and Richmond, a similar comparative incidence of cases was found; the smallest number of cases occurred in the tenements with the largest number of apartments to the tenement.

In a study of 1,000 cases taken from the files in the Borough of Brooklyn

241 cases occurred in private houses,
12 cases occurred in boarding houses,
747 cases occurred in tenement houses.

This would seem to show that the class of dwelling had little bearing on the case incidence of the disease.

These facts are still further confirmed by observations made in particularly crowded sections of the city.

A small and quite isolated residential district in Manhattan lies west of Broadway, between Battery Park and Liberty Street. The 1910 census of this area gives a population of 6,441, with 1,463 families. There has been little change since then. The social and economic conditions are probably as bad as can be found anywhere in the city; the housing is wretched; there is a great deal of overcrowding, the residential section being greatly encroached upon by business buildings.

Another section, the old "East Side" of Manhattan, south of East Third Street and East Broadway to the river, may be compared with this. Here a very conservative estimate of the population is 400,000. In all respects, it is quite comparable to the other district.

In the Battery Park district, with its population of about 6,500, there were twelve cases of poliomyelitis, or nearly two per thousand. In the East Side, or Corlears District, there were 342 cases, or 0.8 per 1,000 population.

From these data, it would appear that there was no real relation between overcrowding and the spread of the disease.

Domestic Animals as Carriers—

In order to determine whether domestic animals of any kind, being affected by the disease, might become the source of infection, special investigations were made by the Department of Health of all sick or paralyzed household pets, chiefly dogs and cats, discovered in premises from which poliomyelitis had been reported. With the co-operation of the American Society for the Prevention of Cruelty to Animals, all such animals were removed to the Shelter of the Society and there studied.

The following comparison by years, for the months of June, July, August, September and October of the number of dogs and cats removed by the American Society for the Prevention of Cruelty to Animals shows the marked increase of the activities of this Society during the epidemic:

Month	Dogs 1914	Dogs 1915	Dogs 1916	Cats 1914	Cats 1915	Cats 1916
June	3,955	3,669	4,345	20,559	22,082	32,099
July	4,119	4,105	5,546	22,161	29,236	94,991
August	5,258	3,873	4,977	22,459	28,845	62,204
September	5,520	3,977	4,034	17,462	24,057	45,888
October	4,788	3,745	3,636	11,557	20,916	34,586
Totals	23,640	19 369	22,538	94,198	125.136	269,768

As the result of these investigations, nothing was found to indicate that these animals were affected by the disease or that they acted in any way as carriers of the infection.

Food and Milk—

In previous epidemics, the theory has been repeatedly advanced that food or drink may act as vehicles of infection in poliomyelitis. The regular water supply and various foods and drink, particularly ice cream cones and soda water, have been under suspicion and investigation. Above all, milk seems to fit the requirements as a medium of infection, although it has never been proved to transmit the disease.

It was decided by the Department, therefore, to make a special study of the milk supply, in cases of poliomyelitis occurring in New York City, and that so important a food might be properly covered, it was determined to apply, in one borough (The Bronx), the same searching analysis of the milk supply, in poliomyelitis, as is employed in the study of typhoid fever. The general plan adopted was as follows:

First, careful inquiry as to the milk used during four weeks previous to the onset of the infection; second, ascertainment of the name of the dealer, in the case of bottled, and the address of the store from which it was purchased, in the case of loose milk; third, in each case, tracing the milk to the country; fourth, close watch kept by elaborate tabulations, on both the dealers and creameries (*i.e.*, country shipping points); and fifth, when any number of cases were charged to a given creamery, prompt investigation at the source of supply, to discover possible contamination.

Data were carefully kept and tabulated by onset by weeks of all cases

supplied by milk dealers. This tabulation included five hundred twenty-five (525) cases who had been served with milk by thirty-three (33) dealers.

Several dealers showed a decided accretion of cases; in one instance, of one hundred ninety-seven (197) cases, and in another, of one hundred seventy-one (171) cases. At first glance, this would seem to lead to a suspicion of individual dealers, but on further consideration it was apparent that the increased accumulation of cases was consistently in accord with the varying amount of milk distributed by each company in the area studied.

The milk involved was largely Grade B pasteurized milk. Some Grade A milk from country pasteurizing plants showed moderate accumulation of cases, in the last week of July and the first week in August. These plants were specially investigated, in the manner above indicated, as in typhoid fever. The result was altogether negative.

Several smaller studies made by the Department, in the course of investigation of food stores in Brooklyn, gave similar results. One investigation, in the Bay Ridge section, showed twenty-four cases of poliomyelitis using milk from twelve different sources. The other, in a different part of the borough, showed fifty-one cases, with seventeen different sources of milk supply.

Of 30,375 babies under two years of age, who were cared for at the Baby Health Stations in New York City, from June 1st to October 1st, 199, or 0.65 per cent., were affected with poliomyelitis, of which number 59, or 29 per cent., died. These babies were affected and succumbed to the disease, regardless of whether they were fed on breast milk exclusively, on bottle milk exclusively, on mixed feeding, or given Grade A Raw, Grade A Pasteurized or Grade B milk. Especially, it is to be noted that, out of 115 babies under one year of age affected with poliomyelitis, 41 were fed on breast milk exclusively, and of this number 6 died of the disease.

Like results were obtained in a study* of 199 cases under two years of age, admitted to the Willard Parker Hospital. Of this number, 42 of the babies affected were exclusively breast-fed, while 97 of the artificially fed babies were given pasteurized milk, a small percentage only receiving proprietary food.

In all these investigations there was nothing to indicate that, in the recent epidemic, any food or drink was concerned in the spread of the disease. Milk at least would seem to have been eliminated as a source of infection in poliomyelitis.

Relation of the Epidemic to General Mortality Under the Age of Two Years—

In studying the relation of poliomyelitis to the infant mortality and to the mortality of children under two years of age in the Greater City, it will be found profitable to analyze the situation from the following standpoint:

(*a*) The relation of the epidemic to infant mortality, that is, to the deaths of babies under one year of age in the Greater City.

* By Dr. May G. Wilson, Cornell University, New York City.

(*b*) The relation of the epidemic to the mortality of babies under two years of age in the Greater City.

(*c*) The relation of the epidemic to the infant mortality as to deaths of babies under two years of age enrolled at under the supervision of the fifty-nine Baby Health Stations in the Greater City.

(*d*) The relation of the epidemic to the infant mortality of babies under supervision of district nurses during July, August and the greater part of September.

For the purposes of this study, comparisons will be made between the first nine months of the years 1915 and 1916, inasmuch as, from the practical standpoint, it may be said that the epidemic had spent the greatest part of its course by October 1, 1916, and in view of the fact that the opening of the public schools received official sanction on September 25, 1916.

At the outset we desire to submit the following tabulation of comparative statistics bearing upon an analysis of this situation, and to which we will refer from time to time in discussing the many phases of the subject:

(*A*) *Relation of the epidemic to the infant mortality—that is, to the deaths of babies under one year of age in the Greater City:*

Despite the epidemic of poliomyelitis, the infant mortality situation in the Greater City, both from the standpoints of rate and number of deaths under one year, has been exceedingly favorable. The infant mortality rate in the Greater City for the year 1915 was 98.2 per 1,000 children born. For the first nine months of 1916 we find the infant mortality rate 98 as against 102 for the corresponding period of 1915. This took place in face of the fact that some 961 infants, or about 11% of the total cases reported, were attacked with the epidemic disease, and that 395 of the infants attacked succumbed. (See Table XXIII in the Appendix.)

Various observers, or rather critics, have presented several reasons for this reduction in infant mortality during the year, among which may be mentioned:

(1) The reduction in the number of births;

(2) The fact that, owing to the prevalence and spread of the epidemic, a larger number of infants were taken out of the City this year than last year;

(3) Because of the greater exodus from the City of infants under one year, a larger number of these infants died outside of the City limits, and the deaths were, therefore, not included in the total number of City infant deaths.

To answer these seriatim:

(1) *The Reduction in the Number of Births—*

It is true that there have been some three thousand eight hundred and forty-one less births this year than last year (see Table XXIII, item 1), and that with so many thousand less births, it is to be expected that there will be numerically fewer deaths. This does not alter the fact, however, that the infant mortality *rate,* which is a true index of the infant mortality situation, and which is based upon the number of births during the year, and the num-

ber of deaths under one year, occurring during that year, is lower than for the corresponding period of last year. (See Table XXIII—item 5.) But even from a numerical standpoint, the number of infant deaths for the first three-quarters of 1916 would have been lower than for the corresponding period of 1915, even had these 3,841 infants been born.

Assuming that for every thousand children born, one hundred would have died before the first year, we would have had some 384 more deaths than were actually recorded for 1916, namely, 10,122. (See Table XXIII—item 2.)

The present figures show that for the first three-quarters of 1916 there were 884 less deaths under one year of age than for the corresponding period of last year. (See Table XXIII—item 2.) If we add to the number of infant deaths for 1916 the 384 which would have taken place had the number of births in 1916 been as large as 1915, we would still find that there were 500 fewer infants dying in 1916 than in 1915. It cannot, therefore, be denied that despite the reduction in the number of births during the year, there has been a distinct numerical saving in infant lives.

(2) *Larger Number of Infants Taken Out of New York City in* 1916?

It is manifestly impossible to secure any absolutely reliable data on this subject. Impressions vary, some inclining to the belief that the number of families and infants under one year leaving the city this year was greater than last year, and others taking directly the opposite view. At first thought it would seem that the prevalence of the disease, and the terror which it struck in the hearts of the parents, would cause a great exodus from the city. It must be remembered, however, that within a very short time after the epidemic had gained a foothold, quarantine regulations became rather rigid, and entrance to other cities and summer resorts near New York was rendered most difficult, so that a large number of parents who actually desired to take their infants away were prevented from so doing. Other parents, again, soon found that the disease had found its way into the very cities and towns which they desired to visit, and they realized that their children were just as safe in New York City, in fact, safer, because of the better facilities, than outside of New York.

Many parents were so taken up with the fear of the disease, that they remained in the city. As they put it, if the child should be attacked far away from home, they might have great difficulty in returning to New York, and in securing for it the proper medical nursing or hospital care.

It seemed probable that at the beginning of the epidemic not a few families, particularly among the Italian population of the Borough of Brooklyn, and the Jewish tenement dwellers of the lower East Side of Manhattan, became panic-stricken, packed up bag and baggage and left the City. This, however, was the exception.

It must be remembered that many of the better situated element of the population who leave the city during the summer months, year in and year

out, remained in the city this summer, either because of the strict quarantine regulations, both here and in other cities, or because of their desire to remain in a large city, with all its conveniences of transportation and treatment in the event of illness. This number, in our opinion, more than counterbalances the number leaving the city at the beginning of the epidemic.

In order, if possible, to determine with reasonable accuracy whether the removal of children from the city during the summer materially affected the infant mortality of the city, an inquiry was sent to passenger agents of all the railroads having a terminal in New York. Replies were received from all of them, and while many of the roads were unable to supply us with the exact figures, the consensus of opinion was that there had been a material decrease in the summer traffic, particularly as far as children were concerned, as may be seen from the following quotations from the replies received:

> "We notice a decided falling off in the ticket sales for both adults and children."
>
> "We know, however, from personal observation, that during the first outbreak of infantile paralysis, before the quarantine was established, that a large number of children did leave the City, but after the quarantine was established, comparatively few did so."
>
> "Our records show that in July, 1915, we sold 6,622 tickets for the use of children under twelve years of age, whereas in July, 1916, we sold 4,106. In August, 1915 we sold 4,622 for children under twelve years of age, and in August, 1916, we sold 637 such tickets."
>
> "Approximately 300,000 adults and 7,000 children left the City during July of this year. For the same month last year 270,000 adults and 7,000 children. During the month of August this year about 250,000 adults left the City and 2,000 children. During the same month last year 245,000 adults and 6,000 children."
>
> "In the sale of half tickets there was a decrease of 4,616 tickets in July as compared with that month last year, and a decrease of 6,579 in August as compared with the same month last year."
>
> "It would be exceedingly difficult to obtain the exact statistics from our records, but an examination of the reports of our principal New York offices for the period mentioned indicate a decrease of approximately 35 per cent. in the number of tickets sold during the months of July and August, 1916, as compared with 1915."
>
> "Concerning the relative number of children leaving the City, our gatemen estimate that there was a slight increase in July and August, 1916, compared with the same period of 1915 in all rail, but a considerable decrease in the children handled over the ferries."

It would seem that there was certainly a decrease in the amount of travel of children during the summer. This does not of necessity, however, mean that there was a decrease in the number of children who left the city, but rather that when children were taken from the city they did not return until the epidemic was over, and that there was a decrease in the number of excursions to and from the city.

Convalescent homes, because of the edict against gathering of children

in groups, naturally received fewer cases of infants and children than last year. Many of them, in fact, closed their doors.

Further effort was made to obtain fairly accurate data as to the comparative number of infants who left the city during the summer of this year, as compared with that of last year by questionnaires addressed to medical inspectors of the Department, who were engaged in general practice, to nurses engaged in school medical inspection, and through inquiries made of 31 public school principals.

As a result we have the opinion of 43 physicians that there were more little children who left the city in 1916 than in 1915, and 27 who believed the opposite to be the case. Four thought there was no difference.

The inquiry of the nurses showed the following:

1915.	1916.
6,711	8,000 children under 2 in families under observation.
5,967—(89%)	7,022—(87.9%) remained in the City.
744—(10.9%)	982—(12%) left the City.

The inquiry carried on through the school principals, which involved a study of families with a total of 19,105 children of twelve years or over, and 2,068 children two years or under, seems to be a better basis upon which to base an opinion than any one of the others above mentioned, representing a fair cross section of the movements of families with children in the populous Boroughs of Manhattan and Brooklyn. The conclusion is quite definite that fewer children of two years or under left the city in 1916 than in 1915.

(3) *Larger Number of New York City Infants Dying Outside of the City—*

The third criticism advanced, namely, that a much larger number of infants died outside of the city limits in 1916 than in 1915 is not justified by any of the figures that we have at our command.

In the answers received from the 74 medical inspectors (physicians in general practice) canvassed, we have reports of two deaths occurring outside of New York in 1916, as against none in 1915.

In the study made through the 31 public school principals, the number of deaths occurring outside of New York City in 1916 was eight, and in 1915, five.

That we might determine exactly the number of children who died outside the city during the summer months, whose deaths should be charged against the city, the Registrar wrote to the State Departments of Health of New York, New Jersey, Rhode Island, Massachusetts and Connecticut, asking them to supply us with the information called for in a questionnaire which we had prepared, a copy of which was enclosed with each letter.

The following are the returns received from the five States mentioned. They do not bear out the contention that an unduly large number of children who were residents of the city died outside of its limits. In fact, the number of deaths of infants for one year of age may be considered small, the total number being 16.

Deaths in New York State, Outside of New York City, of Residents of New York City During July, August and September, 1916.

	Total, All Ages.			Under One Year	One Year	Under Two Years	2 to 4 Years Inc.	5 to 9 Years Inc.	10 to 14 Years	15 Years and Over
	Total	Males	Females							
Anterior Poliomyelitis	24	14	10	..	..	3	8	9	4	..
Diarrhoea	10	5	5	2	..	1	3	1	..	3
Broncho and Lobar Pneumonia	9	4	5	..	..	1	2	..	..	6
All other causes	247	150	97	2	..	2	2	5	9	227
Total	290	173	117	4	..	7	15	15	13	236

Deaths in New Jersey of Residents of New York City During July, August and, September, 1916.

	Total—All Ages.			Under One Year	One Year	Under Two Years	2 to 4 Years Inc.	5 to 9 Years Inc.	10 to 14 Years Inc.	15 Years and Over
	Total	Males	Females							
Anterior Poliomyelitis	13	6	7	..	..	1	2	7	2	1
Diarrhoea	8	2	6	4	..	2	1	..	..	1
Broncho and Lobar Pneumonia	20	13	7	..	..	..	2	2	..	16
All other causes	320	224	105	4	..	2	3	5	3	312
Total	361	245	125	8	..	5	8	14	5	330

Deaths in the State of Rhode Island of Residents of New York City During July, August and September, 1916.

	Total—All Ages.			Under One Year	One Year	Under Two Years	2 to 4 Years Inc.	5 to 9 Years Inc.	10 to 14 Years Inc.	15 Years and Over
	Total	Males	Females							
Anterior Poliomyelitis	1	..	..	8 mos.	..	..	..	..	..	..
Diarrhoea	..	..	..	..	..	..	..	..	..	..
Broncho and Lobar Pneumonia	..	..	..	..	..	..	..	..	..	..
All other causes	..	..	..	..	..	..	..	..	..	..
Total	1	..	..	1	..	..	..	..	..	..

Deaths in the State of Massachusetts of Residents of New York City During July, August and September, 1916.

	Total—All Ages.			Under One Year	One Year	Under Two Years	2 to 4 Years Inc.	5 to 9 Years Inc.	10 to 14 Years Inc.	15 Years and Over
	Total	Males	Females							
Anterior Poliomyelitis	1	..	1	..	..	..	..	1	..	..
Diarrhoea	..	..	..	..	..	..	..	..	..	..
Broncho and Lobar Pneumonia	..	..	..	..	..	..	..	..	..	..
All other causes	..	..	..	..	..	..	..	..	..	..
Total	1	..	1	..	..	..	..	1	..	..

Deaths in the State of Connecticut of Residents of New York City During July, August and September, 1916.

	Total—All Ages.			Under Year	1 Year and Under 2	2 to 4 Years	5 to 9 Years. Inc.	10 to 14 Years. Inc.	15 Years and Over
	Total	Males	Females						
Anterior poliomyelitis	15	10	5	1	2	3	7	1	1
Diarrhœa	2	2	..	1	..	1	..	..	..
Broncho and lobar pneumonia	..	..	..	..	..	..	..	..	..
All other causes	41	19	22	1	1	1	2	1	35
Total	58	31	27	3	3	5	9	2	36

The opinion is therefore fairly borne out that none of the criticisms which have been directed against the estimated reduction of infant mortality along the lines aforementioned, namely, decrease in birth rate, increased exodus from the City, and increase in number of deaths of infants taking place outside of the City, are justified, and that the reduction in infant mortality during the past year was a genuine one, and for reasons which will be given later in this report.

If criticism has been directed against the reduction of infant mortality in general, it has been particularly directed against the marked reduction in the number of deaths from diarrhoeal diseases.

For the first nine months of 1916 there were (Table XXIII—item 15) 1,965 deaths from diarrhoeal diseases as against 2,626 deaths from the same cause for the corresponding period of 1915, a numerical saving of 661 deaths from these diseases.

This criticism was to the effect that a large number of the deaths ascribed to infantile paralysis were due to diarrhoea, and that, therefore, the number of deaths from infantile paralysis in infants should have been less, and correspondingly, the number of deaths from diarrhoea in infants should have been greater.

The total number of deaths from poliomyelitis under one year of age during the first three-quarters of 1916 (Table XXIII—item 8) was 395. For these three quarters of 1916 there were 661 less deaths from diarrhoeal diseases in infants than for 1915.

If we grant, for the sake of argument, that the majority, or all of the 395 deaths ascribed to infantile paralysis in infants were, in reality, infantile diarrhoea, there would still be a saving of 266 infant lives from diarrhoeal diseases and if, to satisfy the most exacting critic, we apply the infant mortality rate from diarrhoeal diseases, of 24.5 per thousand births, to the 3,841 less births which occurred during the year, and subtract these 93 cases from the 266 above number there would even then be a numerical saving of infants from diarrhoeal diseases to the number of 173.

There is nothing unusual or unexpected in a marked reduction in deaths from diarrhoea in infants. This is rather to be expected. In point of fact the deaths of children under one year of age from the four principal causes for the years 1884 and 1914 show a per cent. reduction as follows:

Contagious Diseases	88.7
Diarrhoeal Diseases	75.7
Respiratory Diseases	53.4
Congenital Debility	1.5

Similarly it will be seen that there were fewer deaths from respiratory diseases and from contagious diseases in 1916 than in 1915, so that it is evident that increased care of infants has been conducted all along the line during this year. (Table XXIII, item 15.)

In analyzing the reduction in the number of deaths from diarrhoeal diseases, it may be interesting to note the following:

Deaths From Diarrhoeal Diseases.

Year.	In Institutions.	In Dwellings.	Total.
1915	919 (35%)	1,707 (65%)	2,626 (100%)
1916	668 (34%)	1,297 (66%)	1,965 (100%)
Reduction—1916	251	410	661

Here it will be seen that a reduction took place in institutions as well as in dwellings, and that the percentage of cases in institutions and dwellings was practically the same during the two years.

If we grant that there were a certain number of cases of diarrhoeal disease diagnosed as infantile paralysis, it is surely equally true that, particularly at the beginning of the epidemic, a certain number of mild cases of poliomyelitis with gastro-intestinal symptoms were diagnosed as diarrhoea.

While it is possible that there may have been the normal incidence of error in the diagnosis of some of these cases, just so it is possible that cases of diarrhoea in this and former years were due to poliomyelitis; but to say that the marked reduction in infant deaths from diarrhoea was due to the listing of diagnosis of these cases as poliomyelitis is unjustified and unwarranted by the facts of the case.

We find that the mortality of babies under two years of age during the poliomyelitis epidemic has remained favorable and better than last year. The mortality rate of babies under two years is based upon the estimated population at that age, and the figures for 1916 (Table XXIII, item 6) show a mortality rate of 72.7 as against 78.5 for 1915.

In 1916 there was a diminution in the number of deaths under two years of age to the extent of 764 (Table XXIII, item 4) and this, despite the fact that the estimated population at that age for 1916 exceeded that of 1915 by almost 6,000.

The number of deaths under two years of age from the various groups of diseases in children under two years of age (Table XXIII, item 16) was less in practically every instance than in 1915, and the mortality rate of babies under two years of age for the various groups of diseases (Table XXIII, item 18) was also less, in most instances, than for 1915.

During the period of the epidemic (Table XXIII, item 25) it will be seen that the mortality rate of babies under two years of age from the various groups of diseases was lower in 1916 than in 1915.

1,725 babies under two years of age were afflicted with poliomyelitis, or 0.7 per cent. of the estimated population at that age, and of these 886, or 51 per cent., died. (Table XXIII, items 10 and 14.)

It will be seen from the figures submitted that the infant mortality and mortality of children under two years of age from anterior poliomyelitis is greater than at all ages, 41 per cent. of those under one year affected dying and 51 per cent. of those under two years of age affected dying, as against a case fatality of 26.3 per cent. at all ages. (Table XXIII, items 7, 8, 10, 11, 13 and 14.)

The analysis of the deaths under one year of age and under two years of age, by boroughs, shows, as noted in the table below, that in both instances the percentage of deaths was largest in the Borough of Queens.

Percentage of Deaths From Poliomyelitis by Boroughs—Under One Year of Age.

Borough.	No. of Cases Reported.	No. of Deaths.	Percentage of Deaths.
New York City	961	395	41.1
Manhattan	326	142	43.5
Brooklyn	460	179	38.9
The Bronx	62	23	37.
Queens	97	44	45.4
Richmond	16	7	43.7

Under Two Years of Age.

Borough.	No. of Cases Reported.	No. of Deaths.	Percentage of Deaths.
New York City	1,725	886	51.3
Manhattan	531	279	52.5
Brooklyn	871	441	50.6
The Bronx	104	47	45.1
Queens	174	104	60.9
Richmond	45	15	33.3

Cases of Poliomyelitis Occurring in 30,575 Babies Enrolled at 59 Baby Health Stations from June 1, 1916, to September 30, 1916.

	Number Reported Ill	Of Those Ill			Number Died	Of Those Dying		
		Breast Fed	Bottle Fed	Mixed Fed		Breast Fed	Bottle Fed	Mixed Fed
Under 1 year..	115	41	54	20	36	6	22	8
1–2 years.....	84	7	28	49	23	..	4	19
Totals....	199	48	82	69	59	6	26	27

Of those ill and fed on bottled milk:	Under 1 Year.	1-2 Years.
10 cases given Grade A Raw	9	1
137 cases given Grade A Pasteurized	65	72
3 cases given Grade B	..	3

Of those dying and fed on bottled milk:	Under 1 Year.	1-2 Years.
0 cases given Grade A Raw	..	..
49 cases given Grade A Pasteurized	29	20
2 cases given Grade B	..	2

Were the children affected and those dying well nourished or poorly nourished?

Well	137
Poor	62

In how many of the affected families were there more than one child affected?

(*a*) 180 families—1 child—90%.
(*b*) 16 families—2 children—8½%.
(*c*) 3 families—3 children—1½%.

What was the sanitary condition of the homes in the affected families?

Very good—57; Good—92; Poor—38; Very Bad—12 .

In how many of the affected families were screens or mosquito netting used?

Yes—113; No—86.

Can you state in how many of the deaths there was diarrhoea preceding death? 24.

How many cases of poliomyelitis under one year of age, between 1 and 2, and 2 to 6 years of age were listed in your district during this time?

832 cases under 1 year—17½%.
1,477 cases 1-2 years—31%.
2,448 cases 2 to 6 years—51½%.

Total—4,757

How many babies under two years of age were enrolled at your Station during this period—June 1st to September 30th?

30,575.

This tabulation shows that from June 1, 1916, to September 30, 1916, 30,575 babies under two years of age received the advantages of health station advice and care, and of this number 199 or .65 per cent. were affected with the disease. Of the number affected, namely, 199, 59, or 29 per cent., died.

The type of feeding, as noted, shows that babies on breast milk exclusively, bottled milk exclusively, or on mixed feeding, and given Grade A raw, Grade A pasteurized, and Grade B milk, were affected and succumbed.

Since 99 per cent. of the milk used for the artificial feeding of infants in New York City is pasteurized, it follows that so large a per cent. of the artificially fed children would use pasteurized milk. The fact that only a very small per cent. of the affected ones were fed on proprietary foods bears testimony to the value of the educational campaign waged against these foods by the Department for many years.

CHAPTER V.

Insects as Carriers of Infection.

AN ENTOMOLOGICAL STUDY OF THE 1916 EPIDEMIC.*

Early in August work was undertaken under the direction of the Health Department along entomological lines, with the hope that either positive or negative evidence might be obtained bearing on the frequently repeated suggestion that insects of one kind or another play a part in the spread of this disease. This work is so valuable and suggestive that it is given practically as reported.

* * * * * * * * *

On account of several peculiar facts connected with previous epidemics of poliomyelitis, it has appeared possible that the disease may not be spread directly from one person to another like most acute infectious diseases, but that it may be dependent for its spread upon some intermediate agent, or perhaps upon some other host or living reservoir, or possibly upon a combination of the two. The most patent facts which have suggested such hypotheses are those connected with the epidemiology of the disease. Others made known by laboratory experimentation would seem to show that the disease is passed directly from one affected human individual to another through immediate contact, involving the transfer of the virus from the first person to the nasal passage of the second. That it may be spread through the agency of dust or by various other means has also been suggested.

The facts which lend color to the belief that insects are concerned are numerous, and some seem to be of considerable importance. Epidemics almost invariably begin during the early part of the summer, in late May or June, reach a climax during early August, then rapidly decline and practically disappear in October. This seasonal incidence corresponds with that of certain diseases known to be insect-borne, and does not occur with other diseases, concerning which we know that insects play no part in their transmission. Certain enteric diseases show a marked summer increase, but they also are partly spread by flies. They never show the almost complete winter disappearance exhibited by poliomyelitis in this country. The disease has always been regarded as more abundant under rural conditions, and the present outbreak, although it has occurred in a large city, has not altered this belief, since the Boroughs of Richmond and Queens, the only boroughs which are to any extent rural, have suffered more severely than their heavily populated neighbors. Insects of practically all kinds, except those which depend entirely upon human beings for their existence, are more abundant in proportion to the human population in the country or in

* By Prof. Chas. T. Brues, Professor of Economic Entomology, Harvard University and temporary Entomologist to the Department of Health, New York City.

small towns and villages. Cases of this disease do not usually appear in such a way that they can be positively traced to contact, and many facts connected with their spatial distribution, as detailed in the present report, seem to be more easily explicable on the basis of transfer by insects or other animals, or by both. As a result of epidemiological studies undertaken some years ago in Massachusetts (by Brues), it was suggested that the stable-fly (*Stomoxys calcitrans*) might be the insect agent by means of which poliomyelitis is transmitted. The following year the disease was apparently passed from monkey to monkey by the bites of this fly in two laboratories.*

But these experiments have failed of further confirmation, and cannot now be regarded as free from possible error. As shown later, there is at least one other possible explanation of the epidemiological evidence secured both before and during the present epidemic in New York City.

This summer's outbreak has offered so many opportunities for study that have not previously been available that it is of peculiar interest and value. It has involved a population living under such entirely different conditions from those existing in places where previous epidemiological investigations have been made, that much evidence of an entirely new nature has come to light.

On this account, it has been thought advisable to give a brief summary of a number of facts and observations of more or less general nature, before dealing with the matter from a purely entomological standpoint.

General Distribution of Cases of Poliomyelitis in Greater New York in Relation to a Possible Insect Carrier—Distribution in the Borough of Manhattan.

By the middle of September the incidence of poliomyelitis reached a very little over one per thousand of population (1.01) in the Borough of Manhattan, thus falling considerably short of that in Brooklyn and Staten Island, which will be considered separately. A glance at a spot map upon which the Manhattan cases have been marked shows a distribution and abundance which would seem at first glance to correspond quite closely with the general distribution of the human population of the island. On the east side below 34th Street and above Brooklyn Bridge to the east of the Bowery and Third Avenue, there have been a great many cases, and the map is thickly spotted in conformity with the great density of population in this portion of the City. To the west of this, extending from West Broadway between Canal and 4th Streets northwestward between Bedford at West 4th Street to Grosvenor Street and North River, is another area with a large number of cases. This also corresponds roughly to a heavily populated area, except that this group of cases extends nearer to North

* By Rosenau and Brues at the Harvard Medical School in Boston, and by Anderson and Frost at the Federal Hygienic Laboratory in Washington.

River and further south along West Broadway than might be expected on the basis of population. On the middle west side, between West 23d Street and West 32d Street, are a number of well-defined, small foci which do not correspond to a densely populated area. Again, west of Broadway, between 45th and 70th Streets, a great many cases have occurred over a large area which does not support a very dense population. On the upper east side the abundance of the disease corresponds well with the comparative density of the population, as there is a large number of cases above 95th Street, the incidence dropping off above 119th Street and 124th Street, in close accord with the density of the population. On the upper west side, between Manhattan Street and West 135th Street, is a large, well-defined focus which does not in any way correspond to a thickly populated area.

In general, over the whole Borough of Manhattan the cases have been grouped in a band of varying width, nearly always contiguous to the water fronts of the East and North Rivers, with a narrow portion of the island almost entirely unaffected. This is particularly true south of Central Park, the difference being less marked north of the park. It is thus seen that with some striking exceptions there have been a far greater number of cases per acre in thickly populated areas, with an evident tendency to heavier infection irrespective of density of population along the sides of the island near the water fronts of both the East and North Rivers.

When certain areas are examined more in detail, it is seen that they throw further light on the distribution of cases in relation to population and to other possible factors.

Lower East Side—

The portion of Manhattan east of Catharine Street, the Bowery and Third Avenue south of 14th Street includes a population of over half a million persons. In practically no considerable part of this area does the population fall below 300 persons per acre, and in over half of the acre it ranges from 500 to over 800 persons per acre. Most of the inhabitants are housed in five or six story tenement houses, which line the streets in almost unbroken series. There are large numbers of food-shops and other small stores of various kinds on the street floors of these tenements, and the entire child-population necessarily spends its time upon the streets, the entries to buildings, and the open spaces which serve as back yards to the tenements. Under such conditions it is evident that the opportunities for the spread of contagious diseases must be great, since the number of healthy children that may come in contact with one harboring a contagious disease is greatly enhanced by the congestion of the limited areas in which the children play.*

* As the populations of the small areas here referred to have been taken from the census of 1910, figures from the same census have been used for comparison with the city as a whole. The different rates of growth in various parts of the city cannot have been sufficiently different to change the incidence rates appreciably.

As has been said, the smaller sections of this east side area represent several distinctly different densities of population, which may be grouped as follows:

Area with Over 800 Persons Per Acre.

Area.	Population.	Cases of Poliomyelitis.	Rate Per 1,000.
51 acres	44,500	29	0.6
416 acres	37,700	24	0.6
52 acres	42,000	30	0.7
Total	124,200	83	0.66 rate
		Per acre	0.55

Area with from 600-799 Persons Per Acre.

54 acres	37,700	32	0.8
47 acres	30,400	16	0.5
40 acres	25,100	19	0.7
36 acres	23,100	18	0.7
Total	116,300	85	0.73 rate
		Per acre	0.48

Area with from 500-599 Persons Per Acre.

56 acres	28,600	18	0.6
63 acres	34,900	66	1.9
42 acres	22,800	25	1.1
43 acres	25,700	43	1.7
43 acres	23,500	31	1.3
Total	135,500	183	1.35 rate
		Per acre	0.74

Area with from 400-499 Persons Per Acre.

58 acres	24,400	43	1.7
52 acres	25,700	22	0.8
43 acres	18,800	21	1.1
52 acres	25,500	15	0.6
39 acres	16,300	16	1.0
55 acres	27,100	42	1.5
Total	137,800	159	1.15 rate
		Per acre	0.53

Area with from 100-135 Persons Per Acre.

47 acres	5,600	6	1.0 rate
		Per acre	0.13

From this table it will be seen the area of densest population has had a very decidedly lower incidence than any of the more thinly populated sections in this part of the City. As a matter of fact, the highest incidence has been in the group of 500-599 persons per acre, although this group has not had a noticeably greater incidence except in one small part than the group of 400-499 persons per acre. Thus the only direct relation of density of population to incidence of poliomyelitis has been an inverse one in this district, if the incidence be related to density at all, and this agrees with the general tendency noted elsewhere for sparsely settled regions to be more severely affected.

If in this same district, we compare the incidence with the area, *i. e.*, the incidence per acre, we find that it is more nearly uniform than it is in

relation to human population (with the exception of one small area with only 115 persons to the acre), since this incidence varies only from .48 to .74 per acre. This is suggestive of the possibility that some other population than the human one may take part in determining the incidence of the disease in children. With this in mind, if we compare the incidence in the densely populated sections (see Map 1) contiguous to the water front with the remaining sections, we find that it is as follows:

	Cases of Poliomyelitis.	Population.	Incidence Per 1,000.	Acres.	Incidence Per Acre.
Contiguous to water front	213	145,400	1.46	313	.68
Removed from water front	318	388,300	0.81	615	.51

This indicates that the incidence has been much higher along the water front, both in relation to population and in relation to the actual area of the sections, corroborating the general impression that there has been a well-marked tendency for the cases to group themselves along the water front throughout the City. In this particular instance none of the sections are far removed from the docks which line the river, although the strip selected for comparison lies directly adjacent to the water while the others do not. This grouping is also suggestive of a factor aside from human population and social conditions. It is at least not contrary, but is what might be expected if the rat should bear some relation to poliomyelitis, and might possibly be explained on such an hypothesis.

On the other hand, for no reason which seems apparent, the three sections (see Map 1) which mark the northern limit of the thickly populated district between 9th and 14th Streets, all have a very high incidence:

Cases of Poliomyelitis.	Population.	Incidence Per 1,000	Acres.	Incidence Per Acre.
85	68,000	1.25	129	.66

It does not equal that of the sections along the water front, but is, nevertheless, far in excess of the other sections removed from the water front. Whether this strip supports a larger rat population than its neighbors on the south would be difficult to say. In so far as insects of any kind are concerned, it seems impossible to understand the peculiar distribution of poliomyelitis in this district on the basis of their comparative abundance. It is true that the stable fly is especially abundant along the water front on account of the large amount of trucking which goes on there, but it is not noticeable that the disease has spread along the streets which are most generally used for teams. The disease should follow these streets if the stable fly were concerned, as this insect migrates most abundantly along thoroughfares through which many horses pass regularly. That it has not followed these streets would therefore seem to be significant, especially in

view of its greater prevalence along the northern strip of this district where there is no more traffic than in the other portions further south. One fact which seems perfectly clear is, that under urban conditions of this type where large numbers of persons are crowded in congested dwellings, there is no tendency toward a rise in the incidence of poliomyelitis. This is abundantly shown by the details which have been cited in the preceding pages, and offers poor support to the view that these cases have been contracted as a result of contact with children suffering from the disease, or as a result of contact with healthy carriers of the poliomyelitis virus.

Lower West Side—

Considerable interest attaches to a small group of cases on and about Greenwich Street just north of Battery Park. Only about a dozen of cases have appeared here, the first during the last week in July, and the others in irregular sequence during August into September. This focus has remained entirely isolated from any others, although it is not separated from them by a space devoid of dwelling houses. Its direct connection with a large focus near the West 132d Street docks is, however, evident since there are boats plying daily between these uptown docks and those directly adjacent to the Greenwich Street focus. These boats might easily serve for a transferance of rats, but their passengers come from widely separated parts of the City, and not particularly from affected regions about Greenwich Street or West 132d Street.

Middle West Side—

Although the area to the south of West 33d Street and West of Sixth Avenue has not suffered severely, it shows a very interesting distribution of cases into several small, well-defined, and more or less isolated foci, each of which includes only a few cases restricted to a single block or to two adjacent ones. The grouping and form of these very small foci is of such particular interest that it is dealt with on another page.

Further uptown there is a noticeable concentration of cases in the district adjoining the stock yards in the vicinity of West 68th Street. This group is quite discrete, but the cases are not so closely associated as in a number of other districts. As the group is in proximity to the stock yards, there is here an especially great opportunity for both rats and the various bloodsucking flies, such as the stable fly and the members of the genus Tabanus, which are associated with the larger domesticated animals.

Upper West Side—

An extremely interesting group of cases has developed near North River between West 126th Street and West 142d Street, most concentrated (see Map 2) between West 130th Street and West 132d Street. In this area by the middle of September 42 cases had appeared and later several more had been reported. The density of the population is very much less

than in the district on the lower East Side, which had been referred to on a previous page. It ranges from 83-140 persons per acre, with an incidence of poliomyelitis of from 0.8 to 3.6 per thousand of population, as shown in the following table:

Area.	Population.	Density Per. Acre	Number of Cases.	Rate Per 1,000.	Rate Per Acre.
47 acres	3,900	83	8	2.0	.17
50 acres	6,800	137	25	3.6	.50
47 acres	3,500	176	3	0.8	.06
47 acres	6,600	140	6	0.9	.12
Total	20,800	.....	42	2.0	.22

It thus appears that the incidence in this area of comparatively sparse population has greatly exceeded that on the lower East Side, being as a matter of fact almost double, showing again very evidently that maximum incidence under these quite urban conditions is not a function of the population density. The same fact is, of course, evident by the very irregular distribution of cases in practically every locality affected, but on account of the great number of factors which may be involved, it is difficult to draw conclusions from this. It may be said, however, that it does not accord well with what might be expected if some actively flying insect were concerned in the dissemination of poliomyelitis. It does resemble at first blush foci which have developed in the City as a result of carrier typhoid infection, but many of these poliomyelitis foci cannot be associated with any probable carrier, and besides, the distribution of the whole epidemic corresponds in no way to that of typhoid. This matter is dealt with on another page.

There have been other smaller, and a number of larger, sparse groups of cases in Manhattan, but most of them do not show a sufficient size or concentration to make it evident that they represent really definite differences in incidence. Irregular population distribution and many minor factors might so easily account for them that they can hardly form the basis for generalizations.

Distribution in the Borough of The Bronx—

The number of cases in The Bronx has been comparatively few and the incidence correspondingly much lower than that in other boroughs. There have been no foci of any considerable size or density, although earlier in the course of the epidemic it seemed probable that several were developing. These proved to be evanescent, however, and later cases have produced a quite even distribution over the area north of the Harlem River and between the line of the New York Central on the west and the New York, New Haven and Hartford on the east as far north as Bronx Park and Fordham University. Along its western boundary this area has ex-

tended a short distance west of the railroad, but the western part of The Bronx has been practically free from infection—in fact remained almost entirely so until very late in the course of the epidemic. This western section is very much more sparsely settled than the eastern one which suffered from poliomyelitis, and is quite generally separated from it by much nearly vacant land. Nevertheless, it has continual intercourse with the City. We could find no lack of insects in this district—in fact conditions are favorable for the production of our common bloodsucking flies. The land is considerably elevated and thus well separated from the railroad that skirts the Harlem River Canal. It would, therefore, appear unlikely for rats to reach it from the railroad on account of its sharp elevation on this side. Also, the region is devoted almost exclusively to the homes of the well-to-do, who remove their children from the City for the entire summer.

Distribution in the Borough of Brooklyn—

Since the present epidemic first gained serious proportions in Brooklyn, especial interest naturally centres upon its behavior in this borough. The incidence has been considerably over twice that for Manhattan, and the disease has appeared abundantly in districts of several types. As it has also showed a more or less constant movement or shifting from the first centre, the course of the disease in Brooklyn offers much valuable information.

In the immediate vicinity of its origin in Brooklyn, the epidemic did not gain the intensity which it showed some time later in adjoining districts into which it had spread in the meantime. There has been, however, a great number of cases in the district into which the northern end of the Gowanus Canal extends, an area which is roughly coincident with the first indications of an epidemic. Here the greatest number of cases have appeared in the district west of Third Avenue, north of Third Street and south of Wyckoff Avenue. They have extended to the East River in decreased numbers over a narrow space, and then in greatly increased abundance along the region adjoining the water front from Joralemon Street to Hamilton Avenue. This portion of Brooklyn is rather thickly settled, but the dwellings are to a great extent old wooden houses that do not contain a great number of families. On the whole, it is eminently suited to support a large population of rats and a considerable one of house flies and stable flies, the former on account of its proximity to the water front, its old houses, and the latter also by reason of its numerous stables. On the whole, the sanitary conditions under which its inhabitants live are bad, partly from necessity due to the surroundings and partly from lack of desire for cleanliness.

To the south of this part of the borough, and separated by a narrow strip, is another area in which a great number of cases have occurred. This follows quite closely along the water front and extends as far as 60th Street, with only one or two insignificant breaks. The northern part of

this area is composed of blocks which contain tenements that house a large number of families, and consequently this part has had more cases in proportion to its area than the part further south, which includes a great number of smaller houses. These smaller houses are in many cases old wooden buildings, but many are of far better stone and brick construction, although nearly all were built many years ago. A few newer apartment buildings of small or moderate size are scattered through this southern part of the district. Although of far better appearance in nearly every respect, much poliomyelitis has appeared here. It has undoubtedly shown a preference for the older wooden houses but has nevertheless occurred quite commonly in the neatest of the small brownstone and brick houses. On the whole, the probability of a considerable rat population here would seem less likely than in almost any other part of the City in which poliomyelitis has appeared abundantly.

In proportion to its resident population, Coney Island, which forms the southern end of Brooklyn, has suffered quite heavily. Here there have been two more or less clearly defined foci with a few more scattered cases. The greater part of these has been in old houses under bad sanitary conditions, and neither rodents, flies or insects would be excluded.

The most extensive group of cases in Brooklyn was in an irregular area. The upper arm extends from East River between the Williamsburg Bridge and Greenpoint Park eastward to somewhat beyond Myrtle Avenue. The lower arm drops considerably to the south of Myrtle Avenue as it approaches the west and stops short just before reaching the Navy Yard. The whole group is more or less distinctly separated from the foci further south, but is connected by a narrow group that extends along the southern boundary of the Navy Yard, and then suddenly enlarges to occupy a considerable area about the approaches to the Brooklyn and Manhattan Bridges. Below this, however, there is a distinct break of fully a quarter of a mile before the limits of the first Brooklyn area mentioned is reached. The space between the arms of the above-mentioned include the area bounded by Division Avenue, Broadway, Wallabout Street and the Navy Yard. Within this space only a comparatively few scattered cases have occurred. This section includes much of the older, more thickly settled portions of Brooklyn, and supports a rather uniformly dense population. The incidence of poliomyelitis has been very high, much higher than in the densely populated sections of the lower East Side in Manhattan, although the inhabitants do not live under such conditions of congestion as their neighbors across the river.

The last distinct group in Brooklyn to be mentioned is one which embraces the Hebrew section commonly known as Brownsville. Here the incidence has not been so high as might have been expected from the conditions which prevail. The population is sparser than in the last-mentioned section, but not sufficiently so to account for the great scattering of the

cases. This group is quite sharply limited to the north by Atlantic Avenue, for above this, in the better section, a smaller number of cases have occurred.*

From this it can be seen that the distribution of the cases in Brooklyn has been apparently much more erratic than in Manhattan. Practically all of the water front which supports large shipping activities has had a dense fringe of cases in the residential blocks that extend inland. In this respect it has shown a more or less close agreement with Manhattan. About Gowanus Canal the district affected has extended inward further, possibly through some influence exerted by the canal. The large area northeast of the Navy Yard adjoins the water only for a very small part of its extent, and extends inland over an area of closely built-up blocks of mainly old houses. In Brownsville far removed from the water front the incidence has been lower than might otherwise has been expected, from comparison with other parts of Brooklyn. On account of its strict adherence to the environmental conditions mentioned, it seems evident that the method of propagation, if it be other than chance contact of individuals, must depend upon something correlated with such conditions. The proximity of so many affected areas to the water front, the exceptions being in two closely populated districts of which the one farther removed from the water front suffered less than was expected from living conditions, both point to some population other than the human one. No insect which I have observed abundantly seems to fulfill these conditions, although the epidemiological conditions, including the spread in the Brooklyn areas, would seem to be explicable with little difficulty by rat prevalence and migration.

Distribution in the Borough of Richmond—

Staten Island, the least urban of the Boroughs of Greater New York, has suffered very severely from poliomyelitis during the present outbreak. With a population of less than 100,000 persons and over 290 cases, the incidence has been approximately 3 per thousand. This is particularly interesting since it gives an opportunity to compare the same epidemic under conditions prevailing in the lower East Side, probably the most congested district in the world, with Staten Island, a small city with attendant villages and countryside. The triply greater incidence in Staten Island bears our previous experience that poliomyelitis is a rural disease, more prevalent in thinly settled districts than in cities. This fact of course suggests, as it has in other parts of our own country and abroad, that the dissemination of the infective virus is dependent upon some insect or other animal population which is uniformly more abundant in proportion to the human population under rural conditions than it is in cities. An examination of the island from an entomological standpoint has unfortunately failed to disclose much further information of apparent value. The cases are grouped into what may be conveniently classed as four types. Many are

* Brownsville was infected in the previous epidemic of 1907.

in the older and more thickly settled parts of the island. They have been as a rule in the poorer sections and streets and along the water front, the latter in this case contiguous to the most thickly settled parts. Others have been in suburban residence districts of well-built, well-kept and separated houses. Others have been scattered throughout the thinly settled parts of the island, usually along or not far removed from the main thoroughfares which traverse it. A few have been at summer camps where large numbers of city people are crowded together in small one or two room tent houses or "bungalows." These camp houses have been comparatively free from poliomyelitis, considering their quite considerable population. They are built directly upon the sandy beaches, very generally raised from the ground by wooden blocks or short pillars, and this, in connection with the fact that these camps are vacant during the winter, must reduce the rat population very greatly. If this condition be compared with that in the section of Coney Island which has suffered, it is seen that prevalence of rats is evidently in these two cases parallel with that of poliomyelitis. In the two places flies of the common kinds do not appear to be noticeably different in abundance.

The general distribution in Staten Island is so similar to that already observed during many epidemics in small cities with their surrounding villages and scattering houses, that I have been unable to find any striking peculiarities. Some cases have been almost entirely isolated, but in many instances there have been groups of two or three nearly simultaneous cases. Some of these have been in single houses or families, 21 secondary and tertiary cases in all, or over 7 per cent. of the total 290 cases. This percentage of secondary cases in Staten Island is at least double that in Greater New York as a whole and is difficult to understand on the basis of infection from person to person, since there cannot be twice the opportunity for such contact in Staten Island. This excess should be anticipated, however, in the case of transmission by insects infected from a non-human host, if their population is greater in proportion to the human population. It would result in a greater number of infective agents at work among a smaller number of persons, so grouped that the houses or family stands out as a definite spatial group liable to multiple infection. Such house or family isolation of this type does not occur in the other boroughs to any extent, and we do not find so many double or triple cases in them.

The other groups of two or three cases, mentioned above as near together but not in the same house, have appeared in a number of more or less isolated spots on the island. They would appear to be homologous to the similar pairs or small groups that are continually cropping out in the thickly settled boroughs, due apparently to the appearance of some infective agent. The distance traveled by the agent cannot be traced under the complicated conditions prevailing in the other boroughs, but in Richmond, as in other sparsely settled districts, the distance possible in a short space of

time is evidently at least several miles. This is, of course, easily explained either by the possible advent of a human carrier, or by the appearance of some insect or rodent, since the same method of spread has been observed with yellow fever and bubonic plague when they have spread by introduction into places where they are not endemic.*

As the Staten Island outbreak is being very carefully studied and tabulated by others, their findings may show that some of my own brief observations have been misleading. At any rate the behavior of the disease on Staten Island has been surprisingly like its previous behavior in other small cities, and the divergencies which appear between this borough and the others of Greater New York consequently become of enhanced value.

Distribution in the Borough of Queens—

The entomologist has not given much attention to this borough, partly as it did not seem to exhibit conditions strikingly different from those observed in other parts of the City and partly because of the impossibility of covering such a large area with any degree of completeness in the limited time available. One well-defined focus of about twenty cases in Long Island City was visited. This locality is very much like those referred to in the Borough of Brooklyn, in the region of the Gowanus Canal. It is directly on the water front, adjacent to the yards of the Long Island Railroad, and near Newtown Creek. The area occupied is very closely isolated from any other focus, and the cases appeared over a considerable period during July and early August. Over half (11 cases), however, were reported during a single week following the middle of July. The course of cases in this focus has followed the usual rule observed in others; an isolated case, one or two more coincident or a few days later, after a couple of weeks a considerable proportion of the entire number, then a gradually dwindling scattering of cases.

One other locality in the Borough of Queens which suffered rather heavily was the extensive summer colony which extends along Rockaway Beach. Many cases appeared here in three or four poorly defined groups. Here the conditions are similar to those of Coney Island except that the houses are of better construction and in somewhat better condition. They are, however, old and not of the small type with open-air space below mentioned in connection with Staten Island.

Distribution Summarized—

In reviewing the material presented in the present section of this report the following facts seem worthy of repetition:

In general the cases of poliomyelitis have grouped themselves more or less in proportion to varying density of population in different portions of

* A small epidemic of yellow fever on the Island of Barbadoes described by Boyce, and several small outbreaks of plague in Sydney, N. S. W., are extremely interesting in comparison with the present poliomyelitis epidemic in Staten Island.

the various boroughs. There has nevertheless been a distinct tendency toward a higher incidence in sections directly adjoining Brooklyn.

Great density of population does not tend toward a higher incidence of the disease. This is shown particularly from a comparison of the East Side tenement section with other parts of Manhattan.

Numerous areas have been practically free from infection, while others of apparently similar character and human population have developed extensive foci of poliomyelitis.

Staten Island has suffered more severely than any other borough except Queens, showing the usual tendency of poliomyelitis to affect rural districts more heavily than cities. The high incidence in Queens was reached during the last weeks of the epidemic, as the disease spread to the more thinly populated sections.

Many facts of distribution and general prevalence suggest that the disease is at least to some extent dependent upon some population other than the human one for its spread. Insects migrating by themselves, or on the body of some animal host like a rat, might easily account for the facts dealt with in this section of the report.

Distribution of Cases in Relation to the Immediate Neighborhood.

In referring to the general proportions of the epidemic in the several boroughs, and in the smaller areas where definite foci have developed, it has been impossible to deal with a great many facts which have a bearing on the possible relation of insects to the spread of poliomyelitis. Some of these may be conveniently discussed separately.

The Grouping of Cases in City Blocks—

The completed block in a city forms a more or less definite entity, which differs in many respects from a mere aggregation of dwellings. It is completely walled in on its four external sides and usually encloses a large common space which is divided into yards apportioned to the dwellings. Over quite a considerable part of the areas of Manhattan, Brooklyn and The Bronx where poliomyelitis has been prevalent, the dwellings form entirely, or almost entirely, completed blocks of this kind.

When districts of this kind are plotted for poliomyelitis, it is seen that the distribution of cases is by no means regular; such could hardly be expected with so few cases occurring over a small area. There is shown, however, quite a distinct tendency for the cases to group themselves more or less definitely in certain blocks while others of similar construction, and supporting a similar population, remain entirely free from the disease. This tendency is well illustrated by several maps (pp. 165-169) taken from a district on the middle west side of Manhattan where there have been a number of small foci of the disease. In the first map (A), two adjacent city blocks are seen to be heavily infected, having seven and eleven cases respectively,

divided between two sides of each block, while the contiguous ones have entirely escaped as indicated. In another group (B), one block has suffered seven cases, while in the adjacent blocks only a single one appears across the street from the group of seven. In the third group (C), one block contains five cases, occurring on both sides of the block, while the adjacent ones are free from the disease. In this same small area, three cases appear along the northern side of the lowest block, but none across the street. In the fourth group one block contains six cases, distributed along one side, while the adjacent one has three, only one of which apparently bears any relation to those across the street.

It is not easy to put such data upon a statistical basis, but so many groupings like those figured have occurred that it does not seem possible to ascribe them to chance. It is very evident that they do not correspond with the more common movements of children which would bring them into contact with other children. Such association in playing is more apt to happen between neighbors across the street than it is with those living down the block, around the corner or on the next street (of Fig. 1-A). It is also not easy to believe that any human carrier or any flying insects would show the type of movement or migration necessary to produce case distribution of this kind. It is, however, easier to believe that rats, or even domestic cats might easily migrate in this fashion by the way of yards or back fences. It may be mentioned here that dogs are not generally present in the tenement house districts.

These maps bring out another interesting fact. It will be seen that in the few blocks represented, five houses have had more than one case (4 houses with 2 and one with 3). Multiple cases almost invariably occur in blocks with other cases; that is to say, it is very unusual to find two cases in a single house or family without additional cases somewhere else in the block.

We thus see that there is a tendency for certain blocks to become centres of infection, and that the chances of second cases appearing in families is enhanced by, and seems almost dependent upon, the presence of other cases in the block. This, coupled with the entire absence of the disease in so many blocks adjacent to infected ones is hard to understand on the basis of a healthy human carrier or of flying insects.

Since a large part of the cases of poliomyelitis have occurred in blocks that are used exclusively for dwellings, it has been possible to observe what relation stores, stables, etc., may bear to individual cases. This cannot be satisfactorily tabulated on account of the almost innumerable degree of association with one type or another of food-shop, market, delicatessen, restaurant, bakery, stable, etc., and we have had to rely on impressions gained during the examinations of districts, supplemented by notes made concerning

individual cases. The following list is typical of one of the somewhat better districts where there has been a group of scattered cases in The Bronx.

Case 1. Poultry and meat market in building (Tenement).*
Case 2. Candy store next door (Tenement).
Case 3. Poultry and meat market in building (Tenement).
Case 4. No shops or stables (1½ story old wooden building).
Case 5. No shops or stables (Tenement).
Case 6. Stable next door (2 story old wooden house).
Case 7. No shops or stable (old 3 story brick house).
Case 8. Grocery, candy store, laundry in building (Tenement).
Case 9. No shops or stable (Tenement).
Case 10. Bakery and lunch room next door (old 3 story wooden house).
Case 11. Grocery and dairy in building, candy and ice cream store next door (Tenement).
Case 12. Bakery next door (Tenement).

A second area in Manhattan was as follows:

Case 1. No shops or stable (Tenement).
Case 2. Over delicatessen shop, stable 2 doors away (Tenement).
Case 3. Over stable (brick house).
Case 4. Over ice cream store, macaroni factory next door (Tenement).
Case 5. Delicatessen store next door (Tenement).
Case 6. Over junk shop, grocery next door (Tenement).
Case 7. Grocery on one side, saloon on other, with meat market next (Tenement).
Case 8. Over vacant basement grocery, basement grocery next door (Tenement).
Case 9. Vegetable store in one half of basement, grocery in other (Tenement).
Case 10. No shops or stable (Tenement).
Case 11. No shops (Tenement).
Case 12. Over meat market, adjoining buildings not dwellings (Tenement).
Case 13. Over meat and provision store, "Pork" store next door (Tenement).
Case 14. No shops nearer than market two doors away (Tenement).
Case 15. Over undertaker's shop (Tenement).
Case 16. No shops or stable (Tenement).
Case 17. No shops or stable (Tenement).
Case 18. Grocery next door (Tenement).

* The word tenement is used only for large buildings of four to six stories, each housing numerous families.

There seems to be a well marked tendency for cases in Manhattan to appear in the immediate vicinity of stables, groceries, meat or poultry markets, lunch rooms, delicatessen shops and bakeries or macaroni factories. The kind of stores vary, of course, with the neighborhood, and some of the sorts mentioned do not occur in every district. However, it is surprising with what regularity one or the other is found in the building or next door to a house in which poliomyelitis has occurred. Others who have also examined the same districts with an unbiased mind, seem always to believe that cases range themselves with a definite relation to shops of this type. It has been repeatedly pointed out in earlier epidemics that stables are often associated with cases of poliomyelitis. This has been undoubtedly true in New York during the present summer, but the other association with provision shops has also forced itself upon our attention.

In combination with other observations, the present ones are interesting. Association with stables at one time appeared suggestive in connection with the fact that stable flies might be the carrier of poliomyelitis. Stables support rats as well as stable flies, and as food shops support the former, but not the latter, this is another bit of evidence pointing toward the rat, or perhaps the domestic cat, as these animals are maintained in particularly great abundance in shops of the kind under consideration. It is a generally accepted idea that the presence of cats serves to keep buildings free from rats. This is erroneous as has been abundantly shown by various observers who have found rats and cats commonly occurring together, both in buildings and on shipboard.

In more or less close connection with this matter, there is another which is brought out in our notes taken of individual houses. In the table given on page 150 it will be noted that several cases occurred in wooden buildings. It happens in this district that these buildings scattered among blocks of tenements are relics of a period before the neighborhood was engulfed by the City. These buildings house an insignificant number of persons compared to the tenements, yet they have suffered considerably from poliomyelitis. This is only an isolated example, but is typical of the fact that so far as one can form an opinion by careful observation and reflection, it is the older or more poorly cared for, particularly wooden houses without cemented basements, which suffer most severely. Thus, the house next door, is so frequently found to be at least noticeably better than the infected one, either newer, of better construction, kept in a more cleanly condition, or in better general repair. There are, of course, exceptions, many due as nearly as one can tell to the association with shops mentioned above. In certain parts of Brooklyn, where houses of different ages and types of construction are grouped together, examples of this kind have been especially striking, but it must be repeated that exceptions are by no means uncommon.

The Grouping of Cases in Individual Houses—

In going over areas where poliomyelitis has occurred in the City, one gains the impression that there is a tendency for the cases to be more

abundant on the lower floors of buildings. It has been possible to examine this matter statistically, and also to compare the distribution of poliomyelitis with scarlet fever and diphtheria in this respect. For this purpose, the Borough of Manhattan was selected since only a negligible percentage of the buildings used as dwellings are less than four stories in height. The vast majority of the population is housed in buildings of four and five stories, so that the number of cases occurring on the various floors, should show whether the incidence of the disease really bears a relation to the floor upon which the families live.

For a check, two diseases, scarlet fever and diphtheria, known to be spread by personal contact and to some extent by apparently healthy carriers were chosen. The way in which these latter two diseases are apportioned to the various floors of dwellings in Manhattan during the late Spring and early Summer of 1916, and the distribution of poliomyelitis during the epidemic, is shown on the accompanying charts (pages 171 and 173).

These data are somewhat difficult to interpret as in a number of cases the floor is given as "top" instead of by number. Some facts are, however, clearly evident. On the first floor, there are fewer cases than on the second and third floors, as quite frequently there are stores or places of business on this floor, which reduce the number of available dwelling places. It is seen that 17.9 per cent. of the cases of poliomyelitis were on the first floor, against 12.9 and 11.8 for diphtheria and scarlet fever respectively. On the basement, first, and second floors together, the number of cases of poliomyelitis has been greater and on the third and higher floors together it has been lower, than in the case of either diphtheria or scarlet fever, as is shown in the following table taken from the chart. A very few cases on higher floors and in private houses are omitted; they amount to only 1% of the entire totals.

Basement, 1st and 2nd Floors.		Third and Higher Floors.	
Poliomyelitis	44.3%	Poliomyelitis	54.1%
Diphtheria	39.9%	Diphtheria	58.9%
Scarlet Fever	37.0%	Scarlet Fever	60.5%

In Brooklyn there appears to have been an even greater tendency for the cases of poliomyelitis to be more abundant on the lower floors of dwellings (page 175). Here, however, on account of the number of buildings of only two stories, it is impossible to make a dogmatic statement.

It can be seen that poliomyelitis has been consistently more abundant on the first two floors, and less abundant on the higher ones. This difference implies an infective agent which is more prevalent near the ground; the only other plausible assumption would seem to be that the disease is favored more by the lack of air and light on lower floors than are scarlet fever and diphtheria. This greater prevalence on lower floors is also easily explained by an insect carrier such as various flies and mosquitoes, or by an association with rats or cats. In the case of the rat it would seem that the difference should be more marked. This, however, is only an opinion, not based

on actual facts. Rats do commonly occur on the upper floors of buildings, but presumably in lesser abundance than on the lower ones. In this connection it is noticeable than in children under one year old, at which age it is probable that they play more regularly in the apartment in which they live, the divergence between cases occurring on lower floors and upper ones is greater than in older children, who, it may be expected, spend more of their time down stairs or on the street. The following table illustrates this point:

	Age Under 1 Yr.	Age Over 5 Yrs.
Basement, 1st and 2d Floors	49.3	44.8
Third Floor and above	50.6	55.2
Number of Cases	227	301

In over 500 cases about which data is available, there is a difference of 5% in the number of cases occurring in the lower and upper division of buildings, when we compare very young children and those of considerable age. This is additional evidence that there is actually a selection of lower floors and that this selection is due to the failure of the infective agent to attain the equal prevalence on higher floors.*

Houses in Which More Than One Case Has Developed—

Some very interesting data which bear upon the possibility of insect transmission are brought out by an examination of the distribution and sequence of the cases in houses and in families where more than a single case has occurred. The number of such instances is smaller than happens with most of the acute infectious diseases of childhood. This fact may be satisfactorily explained in several ways, and in itself furnishes no evidence of value. The greatest number of additional cases which occurred in families have had an onset coincident with that of the first, and the number of additional cases has decreased almost uniformly from day to day until after a fortnight a second case almost never appeared. This may have been due to the quarantine measures adopted, which have usually included the removal of the patient to a hospital. In fact the same behavior is shown by scarlet fever, which, together with poliomyelitis is graphically represented on the accompanying chart (Fig. 5). That this may not be true, however, is suggested by the fact that the appearance of the later cases in the same house, but not in the same family does not follow the same curve, but that with the exception of a single drop on the third day, it has dropped much more gradually. Another noteworthy fact is that the number of cases appearing in the same building, but in another family or apartment, is far greater in this epidemic of poliomyelitis than has occurred in 1916 with either scarlet fever or diphtheria. The latter disease has not been included on the chart, but the following table shows the apportionment of later cases by houses and families for the three diseases.

* This study is incomplete and the conclusion therefore not fully justified owing to the fact that no count was made of the children of the specially susceptible ages, or the children of all ages living in apartments on the various floors of the tenements. It cannot be safely assumed that there is an equal distribution of children of all age groups on the different floors of the tenements in New York City.—[*Editor's Note.*]

	Cases in Same Family.	Cases in Same House But In Different Family.
Poliomyelitis	335 or 56%	257 or 43%
Scarlet Fever	198 or 86%	31 or 13%
Diphtheria	73 or 78%	20 or 21%

It is evident that there is a very great difference between poliomyelitis and the other two diseases in the number of later cases that have appeared in the same building, but in a different family. Thus 43% of the additional cases or early half appeared in the same house, but outside the family in which the original case occurred. This is more than double the number (21%) for diphtheria and more than treble (13%) the number for scarlet fever. It seems incredible that such a divergence should exist if poliomyelitis like the others were spread through infection from sick individuals or healthy carriers, and the susceptibility of the exposed individuals is the same.

The gradual dropping off of additional cases from day to day and the large proportion of cases occurring in other families in the house may be easily explained on the basis of the appearance of some non-human population in the house, not definitely restricted by the boundaries which prevent intimate association, followed by its actual disappearance or inability to cause infection after a variable length of time. So far as this evidence is concerned, this population might be composed either of insects or of higher animals such as rodents or cats.

Insects as Possible Carriers of Poliomyelitis—

As has been pointed out on the preceding pages, many facts in the epidemiology of poliomyelitis seem to show the spread of the disease to be such that it is impossible to understand its distribution without assuming either a migrating, *i.e.,* healthy human carrier, or a migrating non-human carrier, either an insect or another animal, perhaps both.

Aside from possible spread through numerous healthy adult human carriers no carefully considered hypothesis has been advanced which does not include some insect in the role of a casual or specific carrier.

There is much experimental evidence in support of the idea of contact. Thus, it has been shown that the virus of poliomyelitis can be recovered from the mouth, nose and intestines in sufficient quantity and in such conditions that it is capable of causing the infection of monkeys upon intracerebral inoculation. This recovery of the virus has actually been made, from apparently healthy persons who have been in contact with children ill with poliomyelitis. After this virus has multiplied in the central nervous system of the monkey thus infected, it is capable of infecting another monkey when implanted upon the mucous membrane of the nose. This of course suggects that human cases may result from infective nasal or buccal discharges, not gaining access to the brain directly, but through the nasal mucosa. While suggestive, this evidence is not conclusive for it is quite

probable that the same procedure could be followed with the virus of rabies secured from a person afflicted with the disease. Other experimental observations upon monkeys have shown that the quantity of poliomyelitis virus present in the blood during early stages of the disease is very minute, and that considerable quantities of blood are required to reproduce the disease in another monkey. This would suggest that infection was not secured from the blood, or that if it were, an insect acting as a biological carrier and not as a mechanical one should be involved. That the virus is not more abundant in the blood of human cases in the early stages of the disease than it is in monkeys would seem probable, although by no means proved, since the experimental transfer from one animal to another is accomplished by use of portions of the infected spinal cord, and departs so widely from what must normally occur that it is possible that stages of invasion in which the blood stream plays a part may be entirely eliminated by the present laboratory methods.

It is quite possible that the virus might be obtained by a blood-sucking insect from the superficial nerves, some of which are commonly reached by the mouth parts at the time of the biting. Similarly, inoculation into these nerves could easily occur at the time of a later feeding by the insect.

As already mentioned, the evidence that insects are a factor in the spread of poliomyelitis is based to a great extent upon epidemiological evidence. Aside from facts of general application referred to in the introductory part of the report, the present epidemic has offered an opportunity to examine the spread of the disease in a totally different environment from those in which it has previously been studied. Such facts and observations have already been given as seem to bear on insects, but attention has been called to only a few ways in which they may be applied to the purpose of the present investigation. No attempt has been made to conduct an actual census of the insects present in houses or apartments where poliomyelitis has occurred, as it did not seem that such a procedure would lead to satisfactory results: It is apparent that a disease so common as poliomyelitis, if dependent upon an insect, must depend upon some abundant species. That any insect occurring in sufficient abundance to account for cases over large areas should be absent in others does not seem probable, and is not in agreement with what is known to occur in the case of other insect-borne diseases. With yellow-fever, for example, the yellow-fever mosquito (aëdes) regularly occurs over large areas (*e.g.*, the southern United States) where the disease does not exist, and it is also regularly distributed in all parts of a city (*e.g.*, Guayaquil, Ecuador), while the cases of yellow-fever occur in such a way that the comparative abundance of mosquitoes does not show a definite correlation with the number of infected ones. Such is also the case with bubonic plague, although here the greater abundance of the disease in parts of a city heavily infested with rats is evident when a number of areas are examined for rat prevalence. For this reason no census of houses has been taken in studying the present outbreak of poliomyelitis, but many cir-

cumscribed areas have been examined for the general type of insect fauna existing there.

There are three types of insects which are suited by their habits and association with man to act as carriers of human infectious diseases. One type includes such insects as lice and bedbugs. The first are epizoic parasites during their entire life and do not commonly pass from one individual to another except during close personal contact. They do not remain alive for any length of time away from their host. Such insects obviously cannot account for the spread of poliomyelitis since cases continually come to notice where a transfer of lice could not have occurred. In fact this commonly is more difficult than the transfer of infection by droplet contagion. A louse-borne disease like typhus fever also shows an entirely different epidemiology from poliomyelitis. The bedbug is less dependent upon its host as it can live for long periods without food and may thus easily change its host. However, it does not commonly migrate on its host, nor probably to any extent through tenement buildings except when impelled by the continued vacancy of apartments. It lives almost entirely on human blood and thus does not migrate on the bodies of animals. Extensive migration of such kinds as would be necessary if it were an active agent in the spread of poliomyelitis, even under conditions existing in the crowded sections of New York seem utterly improbable. In this connection it must be mentioned that the virus has actually been recovered from bedbugs that have fed on the experimentally inoculated monkeys.

Another type of blood-sucking insects which remain quite closely associated with their host are various species of fleas. These insects, like the bedbug, never develop wings and consequently do not migrate extensively through their own activities. They can live away from the body of their host for a shorter length of time than the bedbug, but so far as is known, the time during which they can remain alive depends to a great extent upon the amount of moisture present in the air or in such loose dirt, rubbish, etc., as may afford them a hiding place. They undergo their developmental stages (egg, larva and pupa) either in the nests of rodents, cats, or dogs in the case of our common household species, or in accumulations of dust and fine dirt which may accumulate in the corners or cracks of floors in dwellings. Those species which occur on the cat, dog or on rats and mice are capable of considerable migration, since they usually remain on the host animal continuously after they have reached the adult stage, and thus go with it wherever it may wander.

Until recently it was not believed by us that fleas agreed on any essentials of prevalence or possibilities of migration with what would be required of a carrier of poliomyelitis. Like many insects they were long ago suggested as possible vectors. Conn once regarded them as perhaps associated with the spread of poliomyelitis, but before enough was known epidemiologically to examine them critically. Since Richardson advanced this idea that the disease showed an apparent relation to rats in Massachusetts the

flea question has received more attention. As the seasonal prevalence of fleas seems incompatible with that of poliomyelitis, it was suggested that data be secured on the relative abundance of fleas on cats during different parts of the year. From an examination of cats collected by the Boston Animal Rescue League during 1913-1914 it was ascertained that the seasonal abundance of fleas on cats corresponds quite closely to that of poliomyelitis, in fact more closely than that of the stable-fly at least during the winter. During the winter, fleas become scarce, especially in late winter and spring, attaining their minimum in this case during March, after which they rapidly increased until July at which time the observations had to be discontinued.

The persistence of fleas in smaller numbers during the winter is quite in harmony with the frequent continuance of poliomyelitis into late fall, and their rapidly increasing abundance during midsummer also coincides with the rise of the disease.

If we now compare poliomyelitis with a disease known to be spread almost exclusively by fleas and rats we find a number of striking similarities, but also some very evident differences. A somewhat hasty examination of the literature relating to the epidemiology of bubonic plague made by Dr. Freeman and the writer, tended strongly to confirm our belief that there are many similarities between these two diseases in the development of epidemic foci and the relation of the latter to scattered and more or less isolated cases. During recent times there have been no very extensive outbreaks of bubonic plague in temperate regions where the climate corresponds at all closely to that of the northern countries in which poliomyelitis has been closely studied. The progressive development of a number of small epidemics of plague that have been very carefully followed show a close simlarity to epidemics of poliomyelitis in their main features of distribution. This is especially true of the first general scattering of cases, the beginning of small foci and the way in which an epidemic spreads into new territory while the original small foci may gradually enlarge. As has been shown on previous pages, many features of the distribution and spread of poliomyelitis during the present epidemic lend themselves readily to interpretation on the basis of rats. These, as enumerated and considered in detail are, the grouping of the denser foci along the various water fronts of the city, their development in many localities without definite relation to the distribution and density of the human population, the spread of the epidemic in such a way as rats might be expected to migrate, the grouping of cases in neighborhoods and in houses, etc.

The way in which the small groups of cases have appeared in certain city blocks and the marked tendency of additional cases in the same house to appear outside of the family or apartment are also more easily explained on this basis than upon that of personal contact. The greater incidence of poliomyelitis on the lower floors of the tenements and apartments is also plausibly explained in the same way.

The attempt has been made to ascertain whether rats or evidence of their presence could be found generally in houses where cases of poliomyelitis have occurred. In a great number of instances their presence has been satisfactorily shown by direct evidence such as runways or rat-holes. In others the information has been obtained by questioning residents of the buildings. The last mentioned is very unsatisfactory; in some cases there has been evident exaggeration, and in many others an equally evident desire to deny the presence of anything not considered proper, or anything for which repressive measures might be required by the Department of Health. In others the proximity of stables, bake-shops, meat and poultry stores, etc., has given strong presumptive evidence of rats in at least small numbers. Not many trapping experiments have been tried, but where attempts have been made to obtain them from apparently suitable houses where poliomyelitis has occurred, they have been successful. These rats as was to have been expected have been found to harbor fleas.

The great ease and rapidity with which rats may migrate in both city, suburbs and country have been shown by the spread of bubonic plague, and under urban conditions at least, by actual observations on market rats. Just what opportunities for migration and to what extent rats might avail themselves of these opportunities in a city like New York is a question rather difficult of definite answer without considerable investigation. The occurrence of rats on shipboard is notorious and there is plenty of opportunity for these animals to travel along the water-front following the movements of boats. No experiments have been actually carried on in the city, but there can be no reason to doubt that such travel actually occurs. As mentioned on a previous page one small focus in lower Manhattan is closely associated with a second focus adjacent to another landing of a certain line of steamers. The apparent spread of poliomyelitis has often been seen to follow along water routes, an occurrence usually attributed to the movements of human freight. However, the fact that some of the most noticeable early foci in New York State this summer were about towns regularly visited by steamers from New York City is at least worthy of mention. More people travel by rail from New York City than by water and they reach their destinations more quickly. Nevertheless the water route has been the most rapid for the disease in this case, and the same association with ports has been noted before on occasions not within the scope of this report. Another method of travel open to rats is transportation in freight cars, either free or inadvertently imprisoned in packing cases. Plague follows the same course, and has in some cases been found to follow railroad routes.

In cities the larger sewers support a considerable rat fauna, depending upon the construction, size and condition of repair of the sewers. .The older portions of the city are supplied to a great extent with systems of bricked-in sewers which commonly harbor rats, while many pipe sewers, particularly in the newer districts, offer but small opportunities for rats to escape. Another way in which they may gain access to houses is through large

basement drains which open directly into the sewers without any water-trap. Whether certain streets which have been immune during the epidemic (*e.g.*, E. 116th Street) are supplied with sewers different from those on the adjoining streets, has not been ascertained.

It thus appears that rats and fleas show a number of striking peculiarities in distribution and behavior which are very suspicious when compared with the observed epidemiology of poliomyelitis.

From the standpoint of experimental evidence there is no positive support for the contention that the two are associated. No published reference to paralyzed rats has been made, but we have every reason to suppose that these animals are subject to paralytic diseases such as are known commonly to occur in various frequently observed domesticated animals like cats, dogs, horses, cattle, etc. In none of these animals, however, has it been possible to show that such paralyses as have been observed are identical with poliomyelitis. If we knew that no animal was susceptible, and that none could act as a reservoir for the virus the situation would be much clearer. To deny that animal reservoirs exist is taking much for granted, particularly as it is very probable that even in children a large number of abortive non-paralytic cases occur. That such cases should be the prevalent type in some animal acting as a reservoir is at least perfectly plausible, and we should not expect to find the virus readily recoverable in large quantities from the unaffected spinal cord of non-paralytic animals. Since the spinal cord is the portion of the body usually taken for test, animal reservoirs might easily escape attention unless searched for with great care.

Before leaving the discussion of fleas it should be noted that these insects were not eliminated in the experiments referred to elsewhere, where poliomyelitis was apparently transmitted successfully from monkey to monkey by the bites of the stable-fly.

The second type of insects suited to act as vectors for pathogenic micro-organisms are various actively flying species of blood-sucking habits. The most prevalent forms are mosquitoes and a number of allied flies belonging to several families, gad-flies belonging to the family Tabanidae, and the stable-fly and a few allies belonging to the family Muscidae. No others have a sufficiently wide distribution and occur regularly in all of the regions and localities where poliomyelitis has become epidemic.

The status of the stable-fly has been already mentioned and has been dealt with in detail in other publications. It may be pointed out that the epidemiological evidence which so strongly incriminated this insect in studies of epidemics in smaller cities and in towns and villages does not apply with the same force under conditions existing in New York City. Like other flying insects, its behavior and comparative abundance is not compatible with the observed distribution and spread of the disease as enumerated elsewhere. Viewed in the light of the present epidemic, it seems equally easy to explain at least most of the previous epidemics on the basis of rat and

flea infection, and much easier to understand the development of this summer's outbreak in New York City on the same basis.

Mosquitoes and their relatives do not seem to offer any promising lines of investigation. So far as our present knowledge goes there is no reason to believe that any of them could account for the conditions existing during the New York epidemic. They vary greatly in prevalence in different parts of the city, and while their relative abundance agrees more or less with the general trend of the epidemic, it is difficult to understand the definite foci which have developed, and gradually enlarged with so little change in shape and position. Like other flying insects, the movement of mosquitoes in the country is considerably like that of poliomyelitis, but not so in the city. This statement would not apply to a truly domestic species, like the yellow-fever mosquito (Aëdes), but this species and the Filaria mosquito (*Culex fasciatus*) are notable exceptions. The common rain-barrel mosquito (*Culex pipiens*) is the nearest approach to this habit among our northern species. It is not generally prevalent in a city like New York.

Certain conditions existing in some localities where Tabanid flies of the genera Tabanus and Chrysops are abundant has made it seem possible that these insects might act as carriers of poliomyelitis. The larger species are most abundant along the ocean beaches where these adjoin salt-marsh areas, along rivers, streams and ponds, or about stables, dairies, etc., where large animals are housed. The smaller species (Chrysops) occur almost exclusively in wooded areas and bite man commonly about the head and ears in all of our country districts. Like the stable-fly these flies feed normally upon the blood of animals of various kinds, but with the exception of the largest species, commonly bite human beings also. An extremely annoying species is abundant on the beaches where it goes by the name of "greenhead" on account of its large brilliant green eyes. It is a very persistent and vicious biter. These flies have previously not been free from suspicion as possible carriers of poliomyelitis because of their general prevalence in the country and their abundance on the beaches which are visited so regularly by enormous numbers of persons with children. It is very easy to find that children have recently visited a beach resort and to be led to think that the visit is related to infection with poliomyelitis. The numerous small foci described on an earlier page preclude the possibility that poliomyelitis is usually contracted so far away from home as at the beach, and the lack of outbreaks of greater size in the summer beach camps, is additional evidence. However, these flies frequently occur about stables, even in the centre of the city, where they have evidently flown for considerable distance, since the species breed in marshy lands about streams, ponds, etc. They are attracted only to living animals, however, and do not occur about markets or food shops. Since their bite is severe, it is usually remembered, but only one definite history of a bite of this kind can be recalled after visiting many families where poliomyelitis has occurred in the several boroughs. This does not include beaches; there they are by no means uncommon.

The house-fly has been very frequently mentioned as a possible carrier of the poliomyelitis virus. Its activities have been supposed to be accessory to contact infection from person to person through the medium of the nasal secretions. The flies could of course also secure the virus from fecal discharges or from the secretions or excreta of animals if it exists in such places. In any case they could act only as accessory to some other method of infection. occurring, for example, through the nose or mouth, since flies are attracted to the mouths and noses of very small children as well as to an unprotected wound or surface lesion of any kind. Food might of course become infected in the same way. House-flies may thus be called upon to explain a large percentage of cases where direct contact or carrier infection cannot be shown to have occurred. It is very difficult to analyze a combination of possibilities of this sort, as one sees by recollecting the widely variant views which have been held till recently concerning the relative importance of the house-fly in disseminating the typhoid bacillus. With poliomyelitis the situation is much more difficult on account of lack of knowledge, of many of the important factors concerned. It appears, however, that the numerous differences in the abundance of house-flies in certain sections of the city ought to be definitely reflected in the incidence of poliomyelitis if this insect be a factor. This is not the case, so far as has been ascertained. There are a number of streets very heavily supplied with flies, attracted to pushcarts full of vegetables and other sorts of food, in certain parts of the lower east side. Adjacent to these streets are others where there is no special attraction for flies. There has been no excess of poliomyelitis on such "fly-streets." Flies cannot readily account for the restriction of the disease to blocks either, since flies should show at least as great a tendency to cross the street as to travel along a block or to cross through it into the buildings on the near side of the next street. It is also difficult to see why they should not cause the larger foci, which involve areas including a number of adjacent blocks, to spread more diffusely into the currounding territory than has actually been seen to be the case. At any rate we should have to regard the house-fly as only a contributing factor, additional to spread by contact. That it should act as it does in typhoid-fever by contaminating food is an assumption not supported by any evidence. The failure of certain outbreaks to disappear with the house-fly in the cool months speaks against it as a factory also. The persistence of the present epidemic in Massachusetts is a case in point.

The only other Arthropods suited to convey infections of warm-blooded animals are the ticks and their allies. So far these insect-like animals have been shown to carry only Spirochetae-Piroplasmata and similar organisms. They can be absolutely eliminated as far as human infection of poliomyelitis is concerned.

The development of epidemic foci of large size in various parts of the eastern United States apparently as the direct result of introduction of the

infection from New York City this summer, throws new light upon the peculiar restriction of poliomyelitis to the summer months. This also supplements and confirms observations on the course of the New York City epidemic in the various boroughs.

It is evident that the course of the epidemic has been at first gradual and later has shown an increased rate of acceleration till the maximum daily incidence is reached; after this the decline has followed an inverse direction. In New York City this rate of acceleration has been greatest in the Borough of Richmond, producing a higher incidence in this borough till late in the season when its incidence was exceeded by that of the Borough of Queens. This rate seems to be much more rapid in the more rural portions of the city, even in the more sparsely settled portions of the Bronx. It is also very evident that the early start of the Brooklyn epidemic is casually related to its earlier decline, while the subsequent appearance of the epidemic in Manhattan and Bronx is resulting in a later decline in these boroughs, in the same order as that in which they were attacked.

This makes it appear almost unquestionable that there is a very definite period required for an epidemic to develop and subside and that this period has been almost identical in length this summer for the several boroughs. When this is taken in connection with the late development of the epidemic in Massachusetts and its later persistence in that state in spite of cooler weather than prevails in New York, it is seen that summer epidemics are not regulated by temperature nor by insect prevalence alone. It seems equally evident that one or more factors necessary to produce an epidemic are not present in the winter except in very rare instances. However, once an epidemic has started, it appears to run its definite predetermined course even though this may be prolonged much later in the season in New England than in southern New York. From these facts it would seem that any insect responsible for the spread of poliomyelitis, must be one which remains prevalent much longer in the autumn than the time at which epidemics usually disappear. The stable-fly and fleas of various sorts would fit this requirement, The majority of other insects do not appear to do so satisfactorily on account of their more rapid disappearance upon the approach of autumn in our climate.

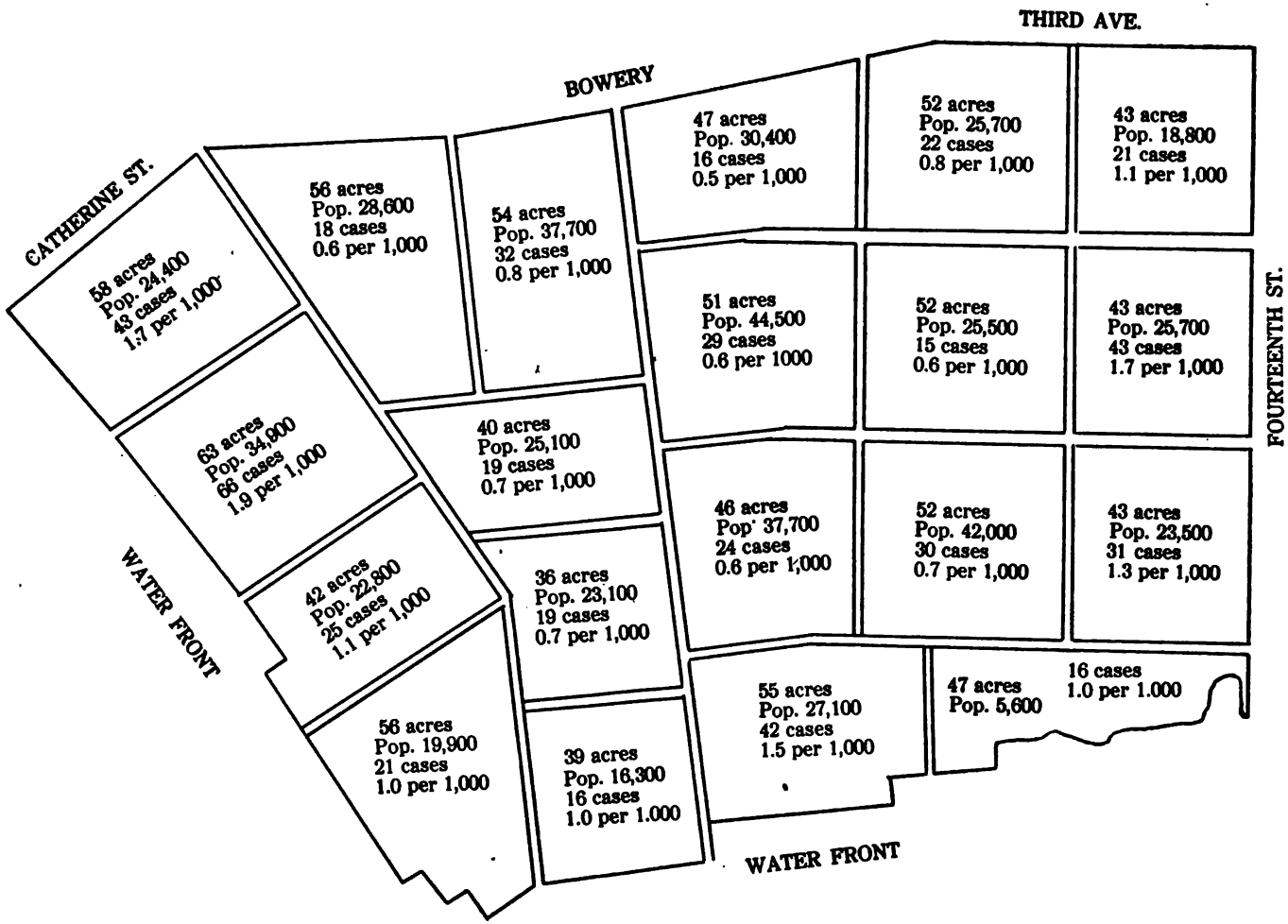
Conclusions.

Some new facts of interest and importance relating to the possible transmission of poliomyelitis by insects have resulted from the present study, but these are not so definite or complete as had been hoped. They are also to some extent of apparently conflicting nature, and require at least one unproven assumption to combine them into any working hypothesis. They do not completely disprove the idea that the stable-fly (*Stomoxys calcitrans*) is implicated, although the behavior of the present epidemic does not favor this view. To discard it is to cast aside evidence derived from

two sets of experiments, however, and it seems very unwise to do this at the present time of uncertainty. As has been shown, it is possible with one assumption to form a working hypothesis based upon rats and fleas which seem to fit the epidemiological observations in general features and in many details as well. The assumption that the rat can act as a reservoir for the virus of poliomyelitis should be capable of experimental proof, and it would seem that such experiments should be attempted.

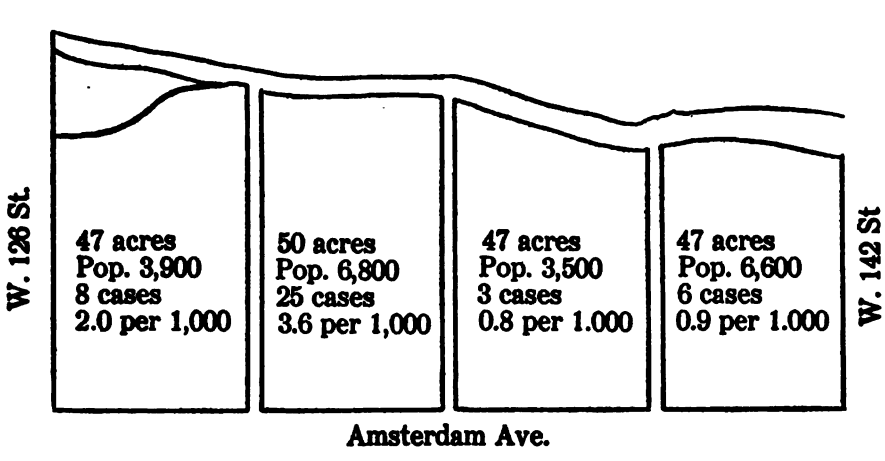
This by no means precludes the association of some other insect or warm-blooded animal, or both. In fact, there is a continual appearance of circumstantial evidence that suggests a population other than the human one, acting as an undercurrent and influencing the progress of the epidemic.

When the many factors so far in doubt are gradually made known, it will be possible to attack the entomological side of the question with better promise of success. Among the unknown factors which cause the greatest confusion in interpreting epidemiological evidence are (1) the length of the period of incubation (2) the number of mild, abortive or unrecognizable cases and carriers of the virus and their relation to infection and immunity; (3) the duration of infectivity in clinically recognized cases; and (4) positive knowledge of the presence of the infective agent in insects, domestic animals, or other possible intermediate hosts or reservoirs of the virus.



Population 539,300; 545 cases; incidence 1.01 per 1,000.

MAP 1.—Part of the lower east side of Manhattan, showing the area, population and incidence of poliomyelitis in the several sections.



Population 20,800; 42 cases; incidence 2.0 per 1,000.

MAP 2.—Area on the upper west side of Manhattan where there was an extensive outbreak of poliomyelitis.

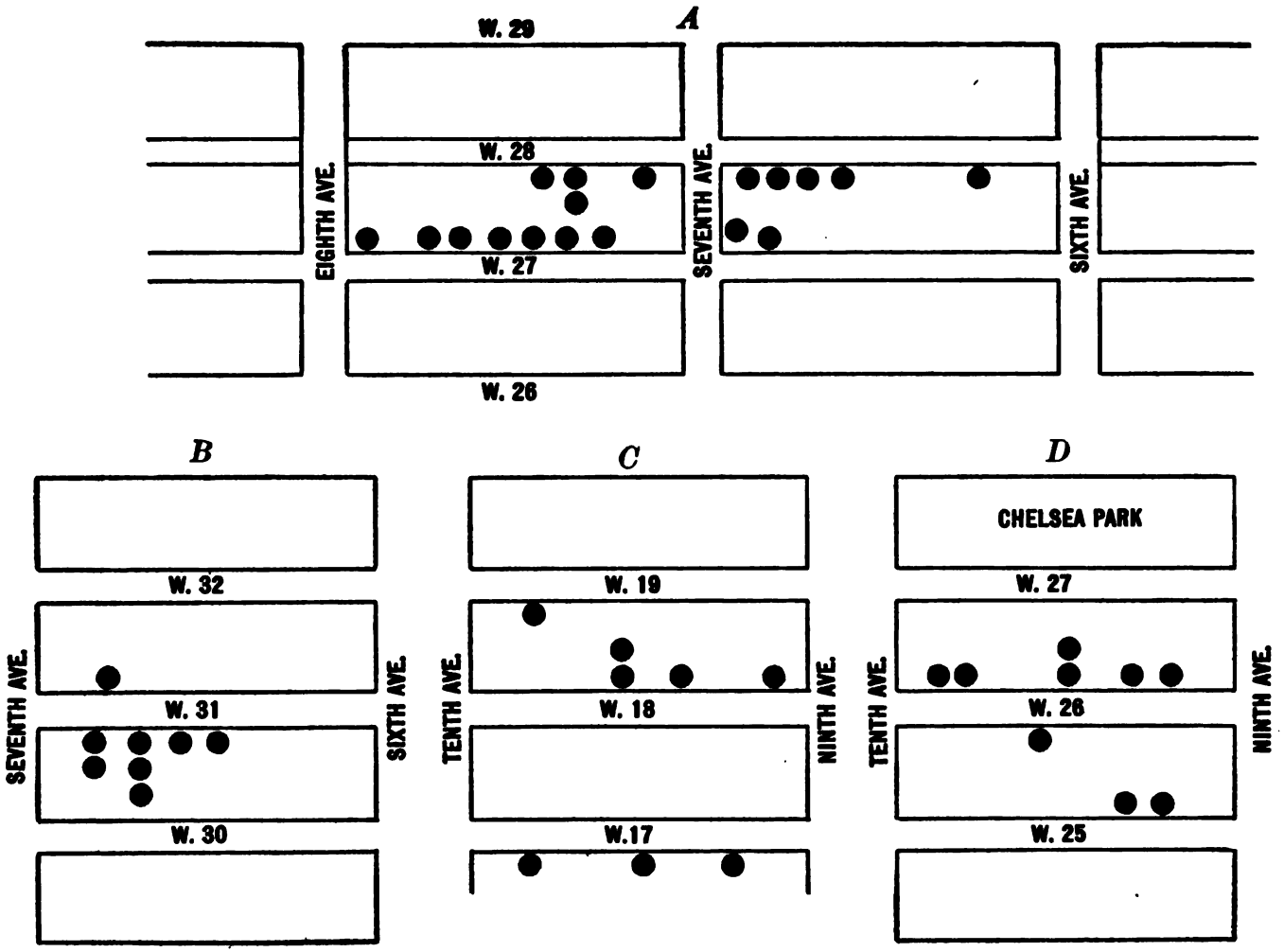


FIG. 1.—Four groups of cases of poliomyelitis on the west side of Manhattan, illustrating the typical grouping of cases. Each dot represents one case; those along the street show the approximate position of the house and those away from the street, additional cases in the same house.

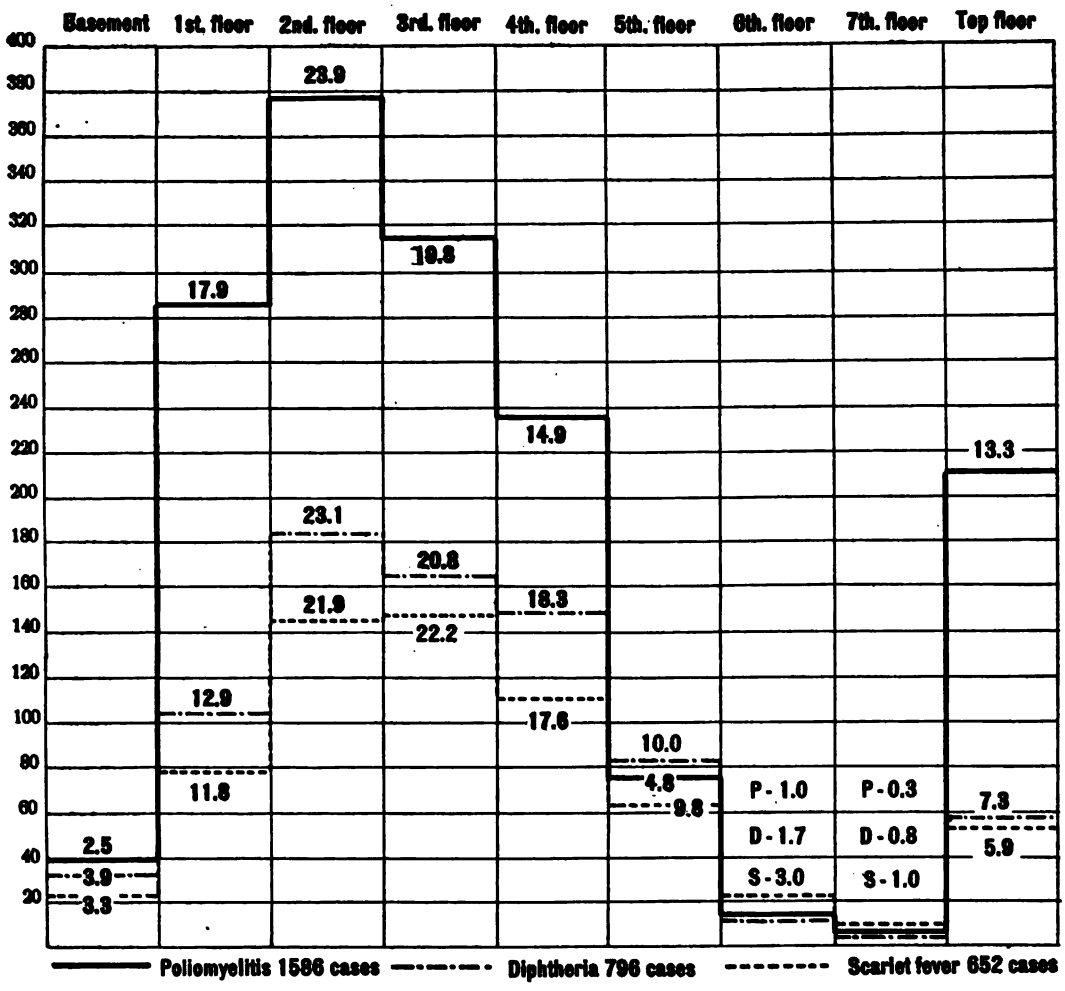


FIG. 2.—Chart showing the prevalence of poliomyelitis, diphtheria and scarlet fever on the various floors of dwellings in Manhattan. The number of cases is shown by the figures at the left of the chart, and the percentage of cases upon a given floor is shown by the figures placed in the vertical columns.

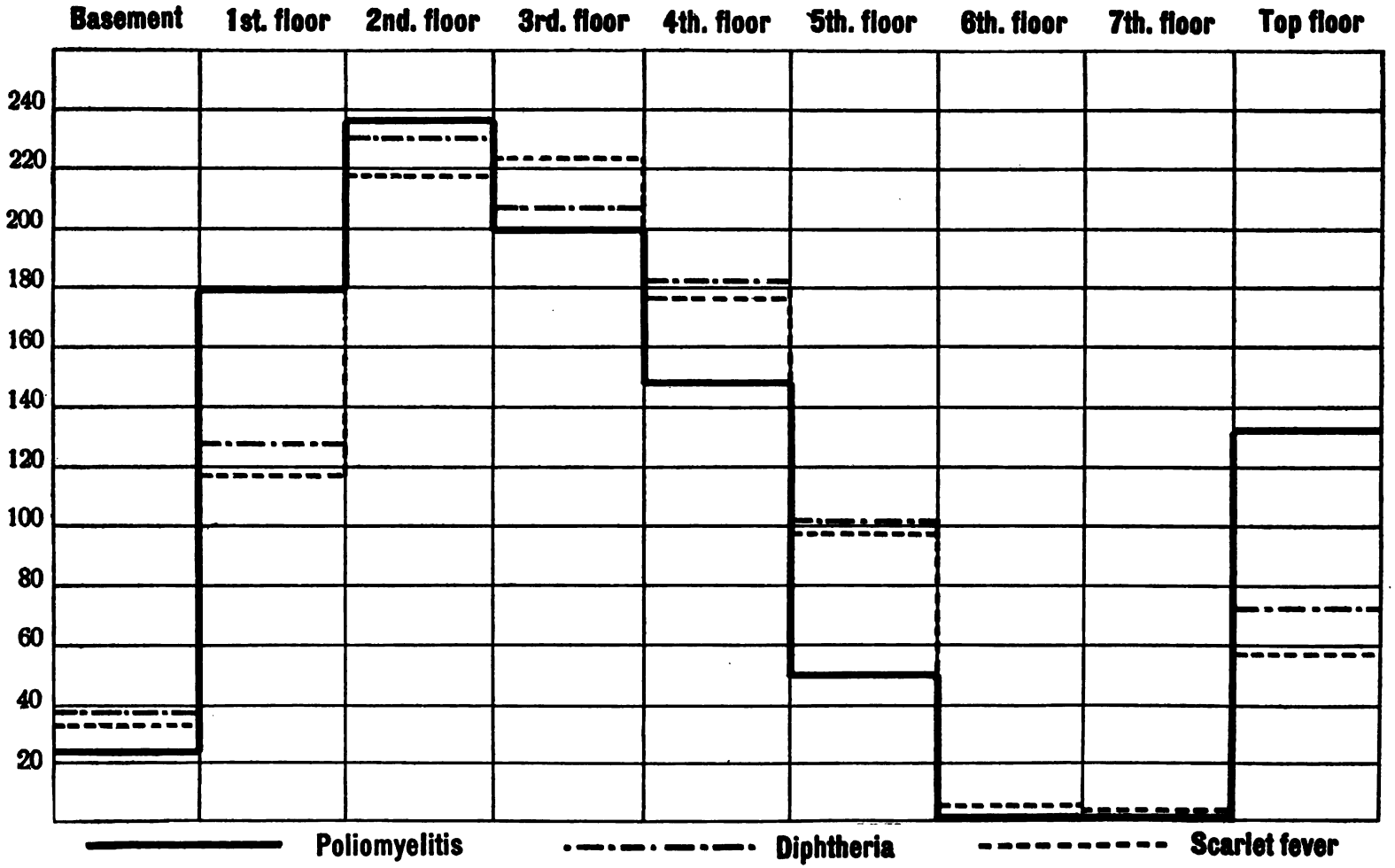


FIG. 3.—Chart showing the prevalence of poliomyelitis, diphtheria and scarlet fever on the various floors of dwellings in Manhattan. The lines representing each disease are reduced to the same scale, the numbers at the left representing tenths of one per cent.

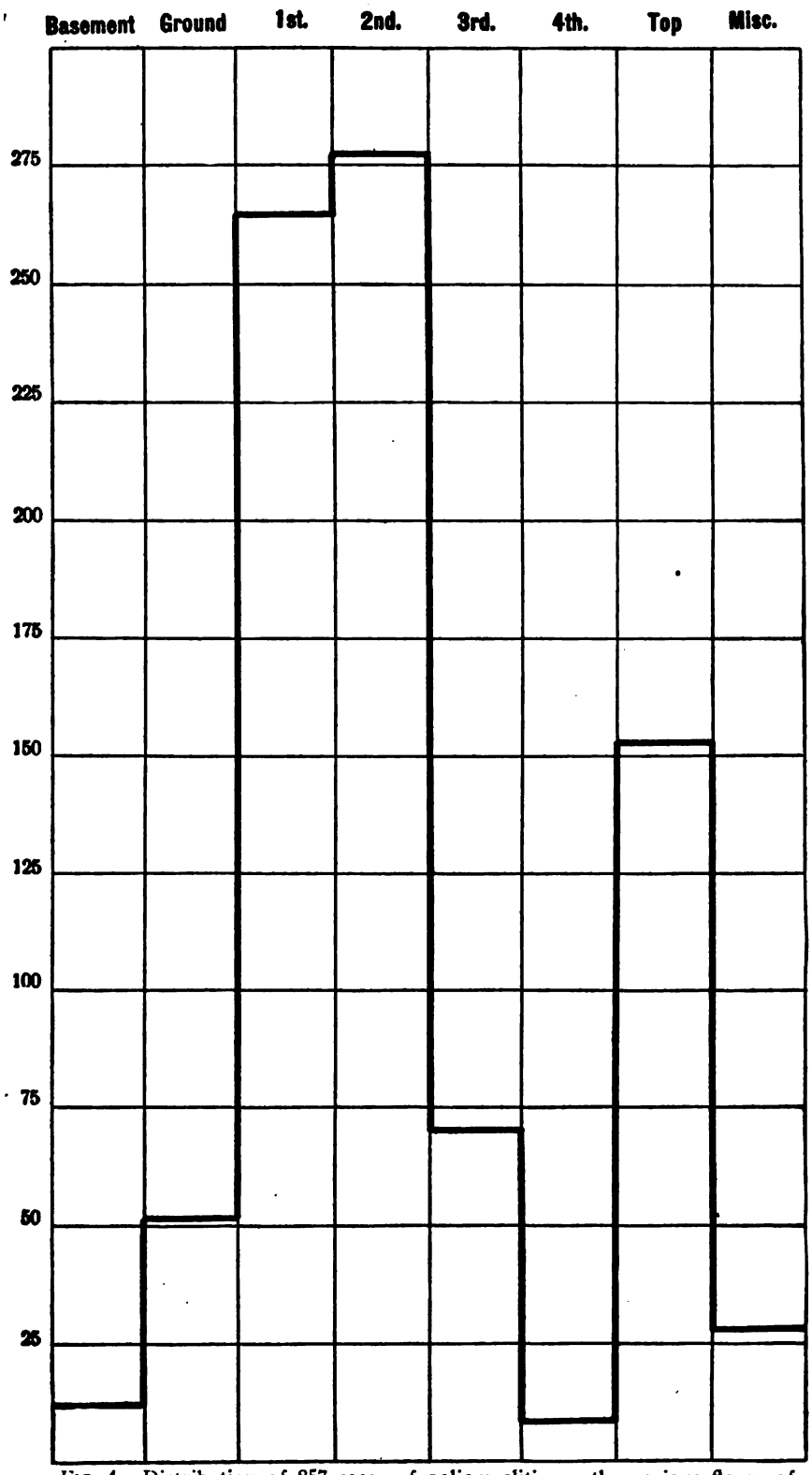


FIG. 4.—Distribution of 857 cases of poliomyelitis on the various floors of dwellings in Brooklyn. Figures at the left indicate number of cases.

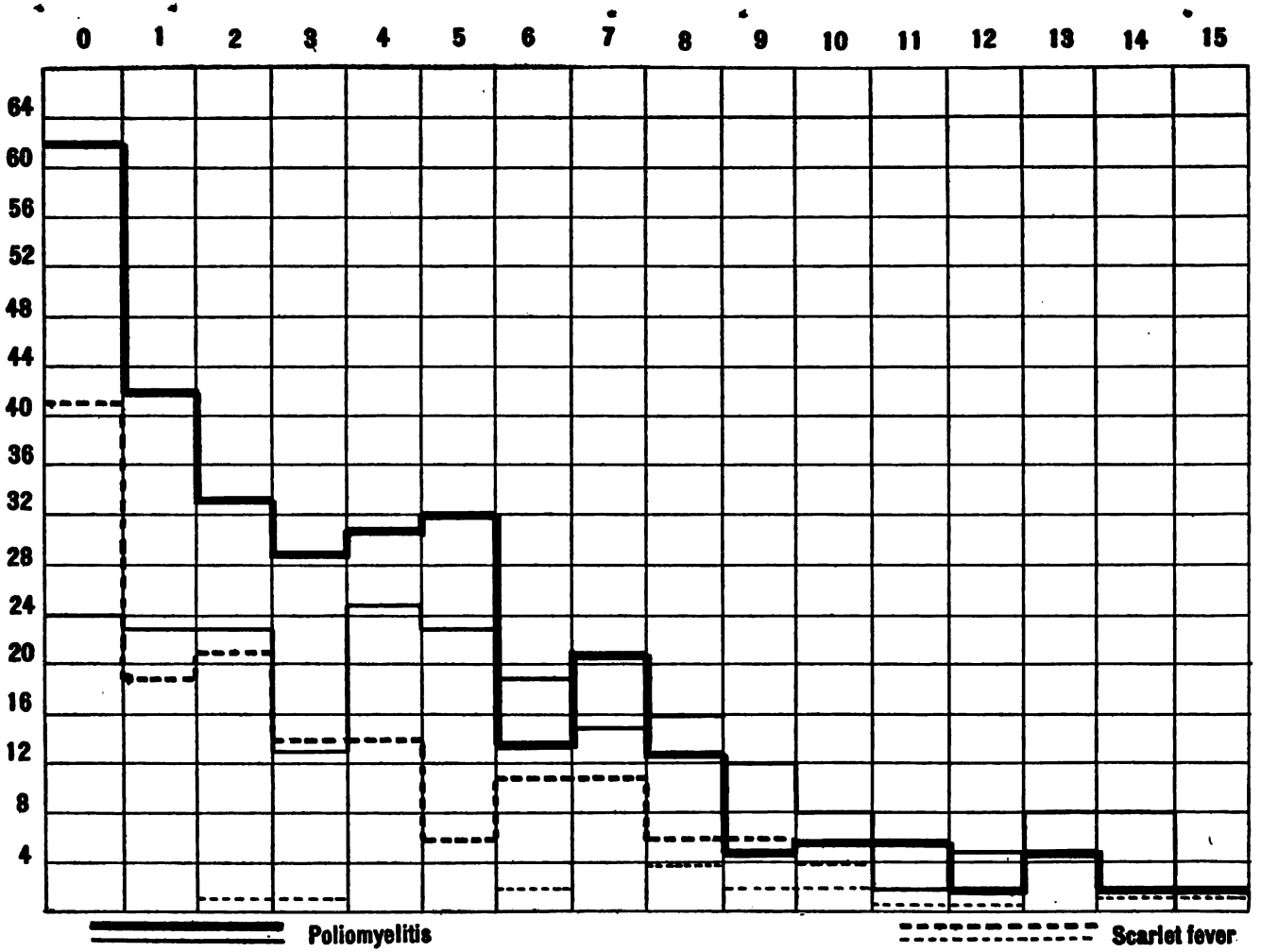


FIG. 5.—Chart illustrating the relation of additional cases of poliomyelitis and scarlet fever to first cases in the same house. Thick lines indicate additional cases in the same family and thin lines denote additional cases in the same house but in a different family. The actual number of cases is indicated by the figures at the left of the chart. The figures at the top of the chart show the number of days elapsing between the onset of the first case and the onset of the additional one. Thus 62 additional cases had their date of onset coincident with that of the first case, 42 were one day later, 33 two days later, etc.

CHAPTER VI.

Poliomyelitis in New York State in 1916.

Summary of Epidemiological Data.

The following data are abstracted by permission from the Preliminary Report of the State Department of Health on Poliomyelitis in New York State in 1916:

Poliomyelitis was made a reportable disease in this State in 1910, but no extensive outbreak occurred until 1912, namely, that which began in Buffalo and spread eastward. This outbreak started in June, reached its height in August, and ceased in October, resulting in a total number of 306 cases.

In Batavia, about thirty-five miles to the east of Buffalo, the outbreak began in August and stopped in October; a total number of 26 cases was reported. Since 1912 many cases of poliomyelitis have been reported from various parts of the State, chiefly from the western portion, 60% being reported in the western third of the State, representing 36.6% of the population outside New York City.

Total Number of Cases and Deaths of Poliomyelitis in New York State Since 1910.

Year.	Cases.	Deaths.	Exclusive of New York City. Cases.	Exclusive of New York City. Deaths.
1910	112	58	112	..
1911	139	52	139	..
1912	1,108	183	604	..
1913	491	123	181	66
1914	224	68	96	29
1915	257	50	162	34
1916	*12,574	3,331	**3,565	81

* Corrected figures (Jan. 15, 1917), 13,164 total cases.
**Corrected figures (Jan. 15, 1917), 4.155 total cases (excluding New York City).

Cases appeared in various parts of the State during 1916. The epidemic was not recognized until the latter part of June, when the outbreak occurred in New York City. The disease spread rapidly to the counties surrounding the city, Nassau and Westchester, and then followed the lines of travel up the Hudson River, along the Mohawk Valley westward to Syracuse, then it extended northward into the western counties of the State. The largest weekly number of cases reported in Nassau County occurred during the week of August 13th to 19th; in Onondaga County, two weeks later; and in St. Lawrence County during September 10th to 16th.

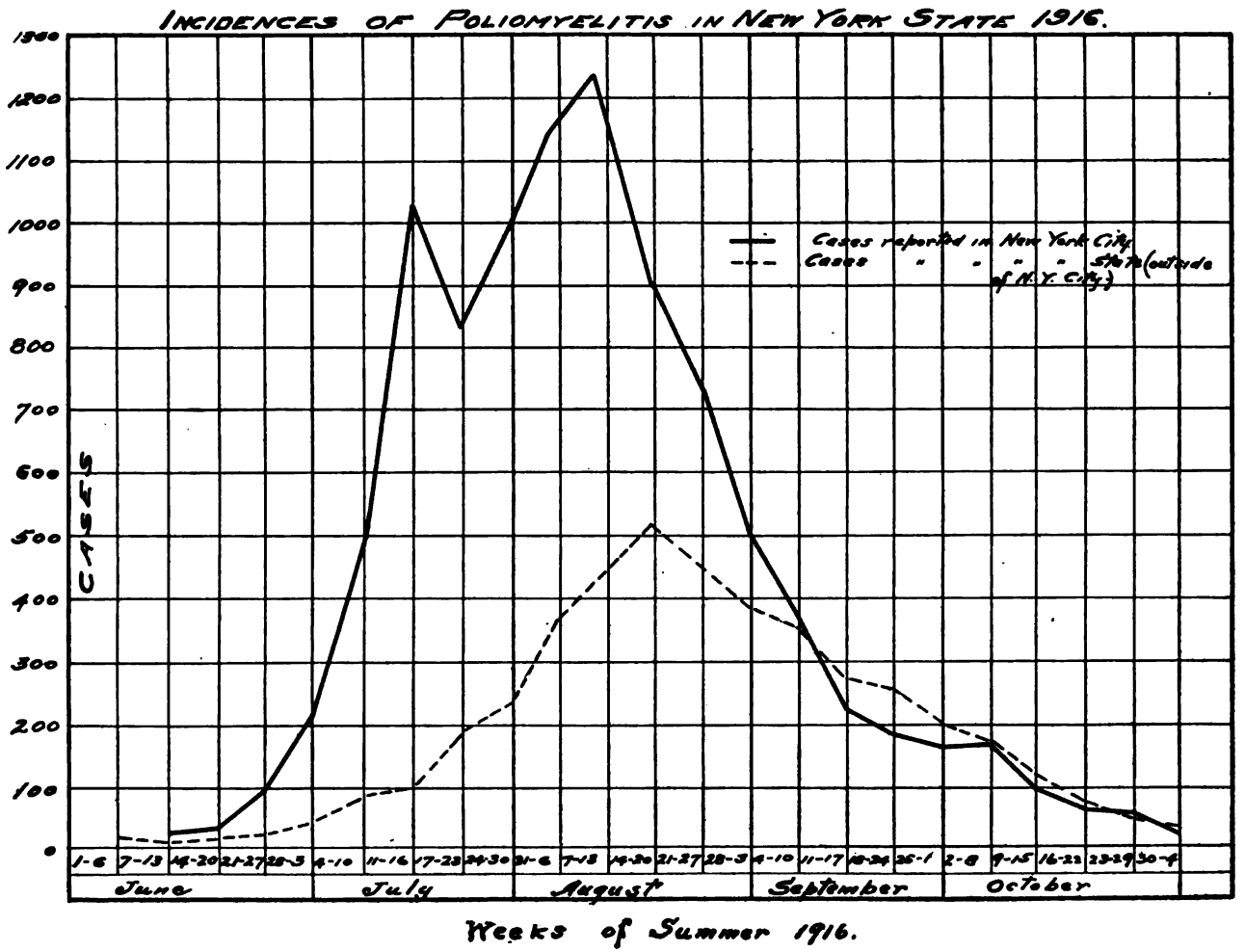
The table given below indicates the incidence of the disease by weeks and months for the months of June, July, August, September and October:

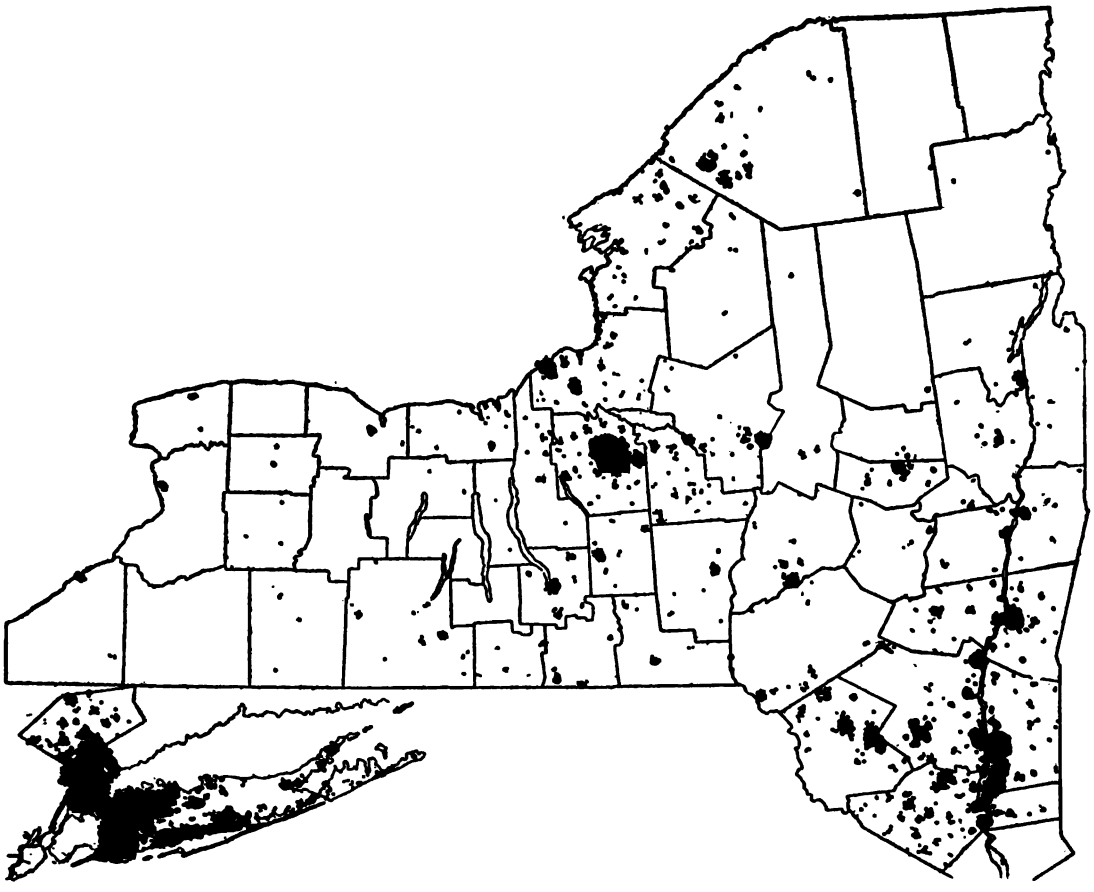
June.		July.		August.		September.		October.	
Weeks.	Cases.	Weeks.	Cases.	Weeks.	Cases.	Weeks.	Cases.	Weeks.	Cases.
1-6	3	4-10	71	7-13	421	4-10	336	3-8	143
7-13	2	11-16	86	14-20	482	11-17	259	9-15	92
14-20	3	17-23	182	21-27	428	18-24	244	16-22	62
21-27	15	24-30	229	28-3	378	25-1	169	23-29	33
28-3	31	31-6	351	....	...	....	...	30-4	25
N. Y. State and City	54		929		1,709		1,008		355
N. Y. City	335		4,373		2,335		878		315

This table shows that the disease, commencing in June, gradually increased during July and reached its maximum incidence in August, about the middle of the month, having attained its height a little earlier in the City of New York, and that after that time it steadily declined, until by the end of October there were comparatively few cases reported.

The total number of cases reported in the State, up to January 1st, 1917, was 13,164, of which 4,165 occurred outside New York City.

The following curve indicates the general incidence of the disease by weeks during June, July, August, September and October. The map shows where the cases were located.


INCIDENCES OF POLIOMYELITIS IN NEW YORK STATE 1916.
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
CASES
Cases reported in New York City
Cases " " " State (outside of N.Y. City.)
1-6 7-13 14-20 21-27 28-3 4-10 11-16 17-23 24-30 31-6 7-13 14-20 21-27 28-3 4-10 11-17 18-24 25-1 2-8 9-15 16-22 23-29 30-4
June
July
August
September
October
Weeks of Summer 1916.



DISTRIBUTION OF CASES OF POLIOMYELITIS IN NEW YORK STATE, OUTSIDE OF THE CITY OF NEW YORK, ON SEPTEMBER 30, 1916

An exact idea of the case fatality of the disease cannot be given on account of the large number of non-paralytic or abortive cases which were unrecognized and not reported. From June 1st to November 1st, there were reported, outside New York City, 3,554 cases with 844 deaths, making a fatality rate of 23.7%. In New York City, during the same period, there were 8,928 cases reported with 2,407 deaths, making a fatality rate of 26.96%. In the State there were, therefore, reported 12,482 cases, of which 3,251 died, or 26 plus per cent.*

As soon as it was realized that an outbreak of poliomyelitis was imminent, the State Department of Health instituted an active sanitary campaign, and provided the necessary organization and equipment to carry out adequate measures to prevent the spread of the disease.

A special investigation was made of the epidemiology of poliomyelitis, the results of which accord very much with those obtained by the Department of Health, New York City. Regarding the prevention of the disease, the conclusion was reached "that it will not be possible to establish adequate and precise measures for the control of this disease until, first, the limits of the reservoirs of infection in nature are definitely known; and second, until the exact means of transmission has been worked out."

In an exhaustive study of 1,081 cases of poliomyelitis, these points are emphasized:

1. 577 were males and 504 were females.
2. The age incidence having the largest number of cases was 2 years; 49% were under 5 years of age.

44 cases were under 1 year.
106 cases were over 1 year old, but under 2.
188 cases were over 2 years old, but under 3.
126 cases were over 3 years old, but under 4.
121 cases were over 4 years old, but under 5.
87 cases were over 5 years old, but under 6.
84 cases were over 6 years old, but under 7.
37 cases were over 7 years old, but under 8.
45 cases were over 8 years old, but under 9.
47 cases were over 9 years old, but under 10.
16 cases were over 10 years old, but under 11.
21 cases were between 11-15 years old.
44 cases were between 16-20 years old.
38 cases were between 21-25 years old.
19 cases were between 26-30 years old.
3 cases were between 31-35 years old.
3 cases were between 36-40 years old.
1 case was between 41-45 years old.
2 cases were over 50 years old.

* These figures to be corrected later when additional data have been collected through the poliomyelitis clinics held periodically throughout the State.

3. Associated in the families with poliomyelitis with those 1,081 cases were 2,579 children, and 3,511 adults, making a total of 6,090 exposed persons. Of the 1,081 cases only 24 were associated with other cases in the same family.

4. In 131 instances the patient was a visitor from out of town.

5. Information about the financial status of the family was obtained in 445 instances. Of these, 140 were in families of the poor, 260 families were in moderate circumstances, and 45 families of the well-to-do.

6. There seems to have been no relation between sanitary conditions and the incidence of cases. Sanitary conditions were bad at the homes of 156 cases, fair in 302, good in 340, and excellent in 215 cases.

7. The previous health of the patient had been poor in 68 cases, fair in 18 cases, good in 372 cases, and excellent in 512 cases.

8. Paralysis appeared before the 4th day of the disease in 71% of 700 cases as follows:

189 had paralysis on the 1st day of illness.
203 had paralysis on the 2nd day of illness.
142 had paralysis on the 3rd day of illness.
85 had paralysis on the 4th day of illness.
48 had paralysis on the 5th day of illness.
29 had paralysis on the 6th day of illness.
20 had paralysis on the 7th day of illness.
14 had paralysis on the 8th day of illness.
6 had paralysis on the 9th day of illness.
3 had paralysis on the 10th day of illness.
2 had paralysis on the 11th day of illness.
2 had paralysis on the 12th day of illness.
1 had paralysis on the 13th day of illness.
4 had paralysis on the 14th day of illness.
1 each on the 15th, 16th, 20th and 21st days.

9. The nationality of the parents was largely American. 709 fathers and 700 mothers were born in the United States; 70 fathers and 61 mothers were Italians.

10. Animals on the premises: There were horses present on 141 premises, cows on 151 premises, sheep on 1, dogs on 162, cats on 189, pigs on 79, goats on 5, and fowls on 284.

The following general observations on the outbreak as a whole are of interest:

I.—"The onset of the epidemic was in New York City, which gradually spread up-state. The most heavily infected region was on the southeast corner of the State. The height of the epidemic appeared in Nassau and Westchester Counties in August, while in the upper counties of the State it appeared in September."

II.—" The cases seemed to follow the course of railroads, indicating that travel may have had something to do with the spread of the disease."

III.—" No milk-borne outbreaks of poliomyelitis were reported. (Neither were there any milk-borne outbreaks of scarlet fever and typhoid during the same period.) The same safeguards were used on dairy farms where cases of poliomyelitis existed that were employed when typhoid fever or scarlet fever occurred. Poliomyelitis was reported on 112 farms during the summer."

IV.—" No water-borne outbreaks of poliomyelitis were noted."

V.—" The seasonal prevalence corresponds to that of typhoid fever. The largest number of cases were reported in August. In previous years the largest number of cases had been reported in September."

VI.—" It is difficult to estimate the exact value of the quarantine measures adopted. In many instances quarantine measures have been enforced vigorously and in other places with laxity. But because adults were not restricted it is evident that only a partial quarantine was maintained. It is significant that institutions located in the midst of infected districts where complete quarantine was rigidly maintained have been free from infection."

The factors demanding special attention are pointed out to be: a simple method of detecting the infectious agent, or at least, of detecting where it is located; a careful study of small groups of cases in order to determine what part of the material transferred from the nose and throat and alvine discharges, from one person to another, has to do with the incidence of the disease; a careful study as to what constitutes immunity from this disease —who are immune and why; an entomological survey of the homes occupied by small groups of cases to determine the common insect life in these homes.

CHAPTER VII.

Pathology.

The morbid anatomy of acute poliomyelitis has received careful and painstaking study by a number of European pathologists, chief among whom are Wickman, with a study of fourteen cases, Harbitz and Scheel* with nineteen cases, and Straus† with eight cases. The findings by all of these workers happily coincide, so that this phase at least of the poliomyelitis study may be said to be practically settled and free from conjecture.

Because of the importance of functional diagnosis and the primary interest in connecting the physical signs and clinical findings with the morbid anatomical lesions as disclosed at autopsy, the emphasis in the reports has usually been put upon the character and location of the lesions in the central nervous system. This has led to a false conception of the true nature of the disease which from the general distribution of the lesions among the lymphatic and glandular tissues of the body, as well as in the brain and spinal cord, should be that of a general infection with the commonest focal symptoms resulting from the damage to the anterior horns in the cord. Many of the general symptoms and not a few of the clinical signs of value particularly in the early preparalytic stage of the disease, result from the general invasion of the body and particularly the lymphatic tissues. It is important to the further study and early recognition of non-paralytic cases that the general, rather than the purely central nervous system lesions of the disease be accepted as essential and typical.

In the present epidemic, post-mortem examinations were performed by pathologists of the Research Laboratory of the Department on forty cases of poliomyelitis, thirty-eight of which died in the acute stages; thirty-six were cases from the Willard Parker Hospital, and four were done in private residences. Nine other cases came to autopsy from the poliomyelitis hospital wards, four of these proved to be tuberculous meningitis; one broncho pneumonia; one congenital heart disease; one purulent pericarditis with purulent pleuritis, broncho pneumonia, and general pyemia; and one intracranial hemorrhage. The poliomyelitis cases confirmed at autopsy, are divided as to sex, age, and duration of illness:

Sex—Male, 37; Female, 13.

Age	
Up to 1 year	8
1 to 2 years	8
2 to 3 years	13

* Harbitz and Scheel: Pathologisch-anatomische Untersuchungen ueber akute Poliomyelitis. Vidensk Selsk. Skr., Christiania. 1907.

† Straus: Report of Collective Investigation Committee in the N. Y. Epidemic of Poliomyelitis, 1907—Jour. of Nerv. & Ment. Dis., Monograph Series, 206, 1910.

Age.

3 to 5 years	2
5 to 10 years	3
10 to 16 years	1
Over 16 years	5

Up to and including 5 years there was a total of 31 or 77.5%.

Duration of Illness—

3 days	10
4 days	5
5 days	6
6 days	5
7 days	5
8 to 11 days	3
Over 12 days	4
Undetermined number of days	2

31 or 77.5% of the cases died within the first week after onset.

The clinical classification as to type is based on the evidence of anatomical lesions. Thus, all cases exhibiting involvement of the lower motor neurone were called spinal cases. These were again divided into two classes; one in which the process begins in the lumbo-sacral cord and progresses upward involving the arm and respiratory centres, and the other in which the process begins in the cervical bulbar regions or in the gray matter from which the cranial nerves have their origin.

Those cases exhibiting disturbance of the upper motor neurone or other disturbances of the sensorium belong to the cortical type. Those cases showing only marked meningeal symptoms were considered to be of the meningitic variety. They are as follows:

Types of Cases.

Ascending spinal	16
Upper spinal	18
Cortical	3
Meningitic	3

One of the ascending spinal cases survived the poliomyelitis infection and died of lobar pneumonia thirty-four days after the onset of illness. Another case belonging to the upper spinal group died of acute gastro-enteritis twenty-eight days after the onset of the polio-infection.

The gross changes when in the brain were usually those of varying grades of congestion of the pial and parenchymatous vessels; of edema of the pia and brain substances. In a few instances the brain tissue was of softer consistency than normal. One brain, in a man of twenty-seven

years, besides intense congestion of the edema, presented extreme softening in one hemisphere involving the motor area and a great portion of the parietal lobe, in which lies the sensory area. Clinically, this man presented a hemiplegia and hemianesthesia of the opposite side. The brain tissue was reduced to a mushy consistency with multiple hemorrhagic flecks throughout the cut surface. No gross hemorrhage was visible and the spinal fluid was clear, with changes such as one would find in poliomyelitis. The Wassermann reaction was negative. This is the only cortical case simulating apoplexy that came under observation, at the Willard Parker Hospital, among a great number of cases. The changes in the spinal cord were observed commonly on cut sections through the pons, medulla and upper cervical portion, it being our intention to preserve as much material as possible, in a clean state, for cultures, microscopic study and animal experimentation. The cut sections presented degrees of hyperemia and swelling of the gray matter. The gray matter bulges above the level of the surrounding white matter and is sharply demarcated from it. In marked cases, the gray matter would be very red, and in some there were what appeared to be small punctate hemorrhages. In other cases, the gray matter is simply pink-tinged and easily marked off from the surrounding white matter. Sections through normal cords fail to show the ready differentiation between gray and white matter which is to be observed in cords from poliomyelitis infection. In some cases the edema involved the white matter as well, and appeared to soften the cord as a whole.

The heart and lungs showed no striking changes except that practically all of the lungs presented acute edema and congestion incident to the paralysis of respiration.

The liver and kidneys showed varying degrees of acute congestion and, in some cases, parenchymatous degeneration.

Particular attention was paid to the lymphatic structures as some observers contend that lymphoid tissue plays a considerable role in the pathologic picture of acute poliomyelitis. The lymphoid structures of the small intestines, the Peyer's patches and solitary follicles, in a number of instances, exhibited proliferation and congestion. The mesenteric lymph-nodes were enlarged and reddened. The spleen, in many instances, showed marked congestion and varying degrees of hyperplasia of the malpighian bodies. Following is a tabulation of gross changes as above described:

	Present.	Absent.	Not Noted or Examined.
Brain	35	5	..
Cord	20	5	15*
Intestine	16	8	16
Mesenteric Nodes	19	10	11
Spleen	18	16	6

* Showed no changes at the level of the sections made.

A number of the autopsies were granted only for the examination of the brain and cord, and this fact accounts for the incompleteness of the data as to the other organs.

The microscopic pictures of our cases are now in process of study. Such as have been looked over correspond with those so carefully described by Wickman, Harbitz and Scheel, et al. The changes in the affected portions consist chiefly in a perivascular round cell infiltration, engorgement of the blood vessels, edema of the interstitial tissue and destruction of nerve cells.

The pia mater is affected most commonly in the sacral and lumbar regions, though congestion of the vessels and infiltration of cells about them may be found in any section of the cord. The gray matter of the anterior horns show, as a rule, the most marked changes, though, in some cases, the posterior horns, especially the gray matter of Clark's column, may be densely infiltrated. Those sections which are the first to bear the brunt of the attack, as a rule, show the severest changes in the ascending spinal cases, usually the sacral and lumbar region; in the upper spinal type, the cervical region, the gray matter about the floor of the fourth ventricle and aqueduct of Sylvius.

In the brain, the regions most seriously affected are the basal ganglia, though the cortex at all times shows changes, most marked, usually, in the motor areas. The intervertebral ganglia, in some cases, have shown changes similar to those seen in the gray matter of the cord and brain.

The cell types, which go to make up the infiltrated mass, consist chiefly of polymorphonuclears, lymphoid and cells derived from the lymphoid cells called poly-blasts. These latter cells have a relatively larger amount of protoplasm than the lymphocytes and its nucleus is paler staining and fasiculated. This cell, as well as the polymorphonuclear cell, exhibit the function of neuronaphagia, that is, they break up and carry away nerve cells that have been destroyed by the virus of the disease. They can be seen in the process of invading the damaged nerve cells, fragmenting it and carrying off the debris. As to the source of these cells, different authors have different opinions. Some think they are derived from the white cells of the blood; others that they are produced by a proliferation of the fixed cells of the adventitia of blood cells; others that they are derived from the neuroglia of the central nervous system.

While the cell infiltration is, as a rule, most marked about the blood vessels, forming a cellular collar about them, as it were, there are to be noted marked diffuse infiltrations as well. The nerve cells, in the neighborhood of most of these, indicated degenerative changes. The cell body swells, and becomes more globular. A disintegration if Nissl's granules occurs. If the process extends, the nucleus is converted into a deeply staining irregular shaped structure. Sometimes complete destruction of nucleus takes place. After this happens, the neurophages enter and clear away the debris.

The edema, when marked, converts the neuroglia into pale staining granular mass. The bundles of nerve fibres, in the white matter, are separated by the accumulation of fluids between them. It is this factor that has to be reckoned with in the explanation of the transient paralyses that occur in this disease. No large extravasations of blood are to be seen. Here and there, small accumulation of red cells have apparently broken through a thin capillary wall. These minute hemorrhages would not show up on gross inspection. So much for the stage of destruction.

In the reparative stage, there is recession of cell infiltration, disappearance of the edema and congestion. The neurophages are carrying off the destroyed nerve cells. There is a proliferation of the neuroglia tissue which gradually replaces the destroyed nerve element. As this neuroglia ages, it contracts and so forms the scars which are to be seen on sections of the cord from old cases of poliomyelitis. As a result of the destruction of the nerve cells of the anterior horns, there is a secondary degeneration of the peripheral nerve fibre, and a consequent atrophy of the muscle supplied by that fibre. The upper motor neurone, which connects with the nerve cell in the anterior horn, also undergoes atrophy because of lack of function.

The microscopic changes in the lymphatic structure consist, generally, of an acute congestion, with hyperplasia of round cells, such a picture as one may find in any generalized infection.

The pathogenesis of poliomyelitis is still an open question among pathologists. Some think that the virus has a direct destructive effect upon the nerve cell, and that the vascularity, edema and round cell infiltration are only the evidence of the body reaction to the presence of the virus. Another school of workers considers nerve cell degeneration secondary to the marked inflammatory reaction; in other words, that the nerve cell is destroyed in a mechanical way by the effect of pressure of the engorged vessels. edema and cellular infiltration.

We agree with the opinion of that school of pathologists which considers the virus a specific nerve cell poison, in a manner analogous to the virus of rabies, tetanus and diphtheria toxin. If one concedes that the infection is principally manifested by disease of the central nervous system, and this is the consensus of opinion, then one must also concede that it is the active elements of the brain and cord, namely, the nerve cells, which have special affinity for the virus of poliomyelitis.

It is probable, however, that edema and congestion play a considerable part in the production of the transient paralysis observed in this disease. With the recession of the edema and congestion, nerve cells, which have been rendered temporarily incapable of performing their functions, are restored to their normal state.

Two factors in the pathogenesis of this disease, the specific cell poison and edema and congestion, are necessary to explain the commonly observed clinical manifestations of acute poliomyelitis.

As indicating the location of the lesion which, in the great majority of the cases, appears to determine the fatal issue, the following summary is included, giving the result of a study of 1,500 of the fatal cases, by immediate personal inquiry and verification of the clinical history and record as soon as the death certificate was received at the Department of Health.

Death was attributed in 61% of the cases directly to respiratory failure.

In 35% more cardiac failure appeared to share in, if not actually to dominate the picture as the cause of death, but in these cases also respiratory failure was a serious factor.

In 4% death resulted from other causes superimposed upon poliomyelitis, as in specific instances, pneumonia, cerebral, hemorrhage, and gastroenteritis.

Among 1,390 of the 1,520 cases which were thus studied and in which the data were sufficiently complete to be trusted, there were 79 patients in whom the paralysis appeared to have been limited to the muscles of respiration, 456 in whom paralysis existed in other groups of muscles as well as in the respiratory group. There were 58 in whom the muscles of the pharynx and larynx alone appeared to be involved, and 354 more where these muscle groups, as well as muscles of the trunk and extremities were involved.

Of these same 1,390 cases it is recorded that:

In 258 there was paralysis of all four extremities.

In 52 there was paralysis of three extremities.

In 443 there was paralysis of two extremities.

In 266 there was paralysis of one extremity.

In the appendix will be found a table (XXII) summarizing the protocols of each autopsy.

Pathological Conditions of Nose and Throat.

In view of the fact that the nose and throat are believed to be the chief modes of entrance to the body of the virus of poliomyelitis, the question naturally arises—what proportion of these organs show actual pathological conditions? In order to answer this question definitely, a special study of 2,000 poliomyelitis patients in the Department Hospitals was made by one of our most expert laryngologists.

The results of the investigation are tabulated below:

	Age of Cases Examined.		Age Ratio Percentage 0/2000 Cases.	Age Ratio Total Epidemic.
Number of cases examined 2,000	Up to 1 year	279	13%	10%
	Over 1 year up to 5 years of age,	1,392	72%	75%
	Over 5 years. Under 16 years (school age)	244	12%	12%
	Over 16 years of age	40	2%	1.9%

Ages.	Number Examined.	Cases with Normal Conditions.	Cases with Pathological Conditions.	Percentage Ratio Pathological Cases.	Pathological Condition Tonsils and Adenoids.	Adenoids only or Retropharyngeal Obstruction.
Up to 1 year.....	279	177	102	36.5%	66	36
Over 1 year up to 5 years of age.....	1,392	499	893	64.1%	829	64
Over 5 years under 16 years of age.....	244	141	103	42.2%	98	5
Over 16 years of age..	40	33	7	17.5%	7	0

Number of cases without previous operation, nose or throat.....	1,955
Number of cases completely recovered discharged from hospitals	550 out of 3,800
Percentage Ratio	15%
Number of cases having previous operation, nose or throat.....	45
Number of cases completely recovered with previous operations..	19 out of 39
Percentage Ratio	46%

Summary of Results.

1. A large number of children with poliomyelitis show pathological conditions of the nose and throat, either diseased and hypertrophied tonsils and adenoids or both.

2. A large number of children with poliomyelitis show marked hyperemia of the naso-pharynx and throat (tonsils and anterior pillars and soft palate), often resembling a scarlet or streptococcus throat.

3. Only a small percentage of cases, previously operated for tonsils and adenoids, were found to be affected with the disease, and in that group of cases the percentage of recovery was very much higher than in unoperated cases. The number of cases in this group is, of course, rather small to draw from it any definite conclusions, but it is at least suggestive.

In another investigation of 1404 children in the public schools, made to determine whether any children, whose tonsils had been removed, had been ill with poliomyelitis during the recent epidemic, a similar result was obtained. The investigation was conducted by trained nurses, under the direction of an experienced District Medical Supervisor of the Department, and the children were examined in thirty public schools.

Following is a list of the number of children operated on by ages, and of the date of operation:

Number of Children Operated on, by Ages.

5 years of age.....	7
6 years of age.....	87
7 years of age.....	191
8 years of age.....	271
9 years of age.....	271
10 years of age.....	220
11 years of age.....	194
12 years of age.....	157
13 years of age.....	4
14 years of age.....	2
Total	1,404

DATE OF OPERATIONS.

Cases operated in 1916	299	(prior to epidemic)
Cases operated in 1915	464	
Cases operated in 1914	323	
Cases operated in 1913	150	
Cases operated in 1912	112	
Cases operated in 1911	33	
Cases operated in 1910	13	
Cases operated in 1909	4	
Cases operated in 1908	4	
Cases operated in 1907	1	
Cases operated in 1906	1	
Total	1,404	

Of the 1404 children where tonsils had been operated upon, not one developed poliomyelitis during the epidemic, although in 18 instances, cases developed in the family and in 93 instances, cases developed in the same house.

CHAPTER VIII.

Symptomatology.

The symptomatology of poliomyelitis corresponds to what one would expect from a consideration of the pathology of the disease as a general infection, with the lesions most marked in the central nervous system. The clinical manifestations exhibit a widespread and scattered motor paralysis or weakening.

The large majority of all cases are of the well known spinal form, but there are many variations in the disease described by Wickman* as types, in which the symptoms are not of the usual kind. His classification and description of these types have enabled us to recognize clearly the multiform character of the infection.

Any classification, however, of a disease so protean in its manifestations as poliomyelitis is at best unsatisfactory, as no one classification will cover all cases. Wickman's classification of the affection into the spinal progressive, bulbar, acute encephalitic, ataxic, meningitic, poly-neuritic and abortive types is comprehensive, but it is open to the objection that it is based both on pathological anatomy and symptomatology. Moreover, it is rather complicated for general clinical use. Mueller's† classification is simpler, namely that of spinal, bulbar, cerebral and abortive forms. Peabody, Draper and Dochez‡ advocate a still simpler description, namely, abortive, cerebral and bulbo-spinal. We would suggest the following classification based wholly on pathological anatomy:

1. *Non-paralytic or abortive type—*

Under this head are included cases in which the nerve cells are not sufficiently injured to produce paralysis, though there may be weakness. Under this type also should be classed meningitic cases and those somewhat like tuberculous meningitis but without motor disturbance, often called encephalitic. In these cases, the motor cortical areas are not involved, but there is evidence of disturbance of the sensorium.

2. *Ataxic type—*

Here the motor cells are evidently not involved, but there is a lack of co-ordination, ataxia, nystagmus, etc. The anatomical basis for this is proved by post-mortem findings of involvement of the cerebellum, Clark's column, and the intervertebral ganglia. This type is very rare.

3. *Cortical type—*

The upper motor neurone is here affected with resulting spastic paralysis. This group is also very infrequent.

* "Die Akute Poliomyelitis"—Berlin, 1911.
† "Die Spinale Kinder Laehmung"—Berlin, 1910.
‡ Monograph No. 4, Rockefeller Institute—1912.

4. *Ordinary spinal or sub-cortical type—*

Here the lower motor neurone is affected with resulting flaccid paralysis.

A manifestation of poliomyelitis difficult to classify is blindness.

The most important symptoms of the disease may be described under the non-paralytic or abortive cases, and those of the ordinary spinal form.

Non-Paralytic Type.

Non-paralytic cases are very frequent, and they are often unrecognized and unrecognizable. In some epidemics they constitute from one-fourth to one-half of the diagnosed cases. Wickman found 25 to 56 per cent. of non-paralytic cases in the total incidence of the disease, and he considered these figures far too low. Mueller supports him in this opinion, and believes that the non-paralytic cases outnumber the cases of frank paralysis.

The symptoms in the non-paralytic cases include those of general infection, cases with meningeal irritation, cases with much pain, and cases with marked digestive disturbances. The characteristic of the abortive cases, however, is that they are not followed by a frank paralysis.

As early symptoms may be mentioned, fever, vomiting, slight diarrhoea or constipation, listlessness, unusual fretfulness or drowsiness. Perhaps muscular tremors or spinal pain may be present. If carefully observed, it is noticed that the child develops slight paralysis of one or more groups of muscles, but instead of continuing, the paralysis disappears within a few hours. Many cases, however, develop no paralysis at all. These cases, nevertheless, are believed to be causes of infection, and it is obvious that their recognition is of extreme importance in controlling the spread of the disease.

The diagnosis of poliomyelitis, when paralysis is no longer present or has never been present, may be greatly facilitated by the examination of the spinal fluid and by the use of the biological test for immunity. The spinal fluid, when examined, macroscopically, microscopically, and chemically gives helpful evidence. The biological or so-called immunity test is less practical or reliable, involving, as it does considerable time, and the not altogether constant performance of a monkey when virus, even of high virulence, is exhibited. If the blood serum of a true case is mixed with virus of known strength and the combined material inoculated into a monkey, failure to develop the disease in such a monkey is considered presumptive proof that the patient's blood serum contained a substance which neutralized the virus and rendered it inert. If, however, the monkey develops the disease, one cannot positively conclude that the patient has not or has not had poliomyelitis. Both the examination of the spinal fluid and the "immunity test" leave much to be desired in the way of specificity and constancy of results.

Ordinary Spinal Type.

This is the common form of the disease which has been long known and often described, but a summary of its principal features should be given. After an acute onset of greater or less severity, motor paralysis appears, reaching its maximum usually within three or four days.

The early symptoms most commonly seen in this type are much the same in all types of the disease, namely, fever, listlessness, drowsiness, sweating, irregular breathing, dyspnoea, hyperesthesia, headache, gastro-enteric disturbance. There is often noticed a peculiar position of the child in bed, one of apparent great discomfort. There may be slight rigidity of the neck, pain on forward traction, with slight Kernig. There may or may not be difficulty of micturition or defecation, and sore throat. Muscular tremors, irregular from fine to coarse, may be observed, especially of the hands and fingers, but also apparent in the entire extremities; weakness of the limbs, more particularly in the lower extremities, with early diminution or loss of patellar reflexes; and finally the character of the spinal fluid obtained by lumbar puncture, which, even in the early stages of the disease, is usually characteristic.

This fluid, in some cases, at the very onset of the infection, has a peculiar "ground glass" appearance (to be discussed later), while, in other cases, it is clear and has occasionally a yellowish tint. Microscopically, it shows a predominance of mononuclear lymphocytes. There is an increase in albumen and globulin, and Fehling's solution is reduced.

Later and more definite symptoms are: pronounced weakness of any of the extremities, skin and muscle sensitiveness, spinal pain, rigidity of neck and back muscles, Kernig's and MacEwen's sign. The temperature ranges usually from 102 to 104 or 105° until the paralysis is complete, when it falls to normal, by lysis, or, rarely, by crisis. The pulse rate remains high, noticeably higher than the temperature would indicate. But the flaccid motor paralysis and loss of reflexes, may be said to be among the most characteristic symptoms of the disease.

The onset, in the great majority of cases, is abrupt, but at times it may be insidious and the disease is ushered in by somewhat indefinite symptoms of an intestinal or anginal nature. A remission of from one to several days then occurs, to be followed by a return of all symptoms and usually by an accompanying paralysis. Fever is often the first symptom. As a rule, there is hyperesthesia or diffuse tenderness over the whole body, which may persist from one week to two or three months. This is, perhaps, most marked in the legs and along the spine. Not infrequently, the first sign of paralysis in the child is noticed by the mother or nurse, after an injury, as from falling from a chair or when walking, etc., so that a history of injury as the cause of the affection may call attention to the disease.

While paralysis may, in rare instances, appear two or three hours after illness, clinically it is seldom possible to demonstrate it until three or four days later. A stationary period follows the development of the

paralysis, after which begins a spontaneous improvement in muscle power, continuing six months or a year longer. The final paralysis, however, is invariably less than the initial, if the patient lives. The paralysis is more often partial than total, whether of an extremity or of the whole body. Deformities occur. Reflexes are diminished, and also sensation is affected. Disturbances of circulation occur in the severer cases, so-called trophic disturbances, causing the paralyzed part to be usually cold. This, in winter, may give considerable trouble with trophic ulcers, chilblains, etc.

Several other types of the disease have been described, but one type, clinically, is frequently merged into the other. The following six additional types described by Wickman may be briefly mentioned, as they belong to the classics of the literature of poliomyelitis.

Progressive Type.

This type, in which the paralysis appears first in the arms, extends downward and finally upward to the muscles supplied by the medulla. When the paralysis reaches the external muscles of respiration (not the centers of respiration in the medulla) death is apt to ensue, and usually on the fourth or fifth day. This is the type which probably was formerly described under the term " Landry's Paralysis " and is practically identical with it.

Bulbar Type.

This type, in which the cranial nerve nuclei are involved, the symptoms depending on which of the cranial nerve nuclei are affected,—facial, abducens, vagus, etc. There may be paralysis of deglutition and the muscles of the larynx. When the vagus is involved, there are disturbances of respiration and of cardiac action. The respiration is at times of the Cheyne-Stokes type. Involvement of one or more of these cranial nerve nuclei is not uncommon in the ordinary spinal type, the resulting picture in these cases being a combination of the two, or bulbo-spinal type.

Acute Encephalitic Type.

This type, with symptoms resembling those of acute meningitis: the deep reflexes, as a rule, are exaggerated and the paralysis is spastic. Diagnosis is usually impossible without lumbar puncture. This type was discussed by Strumpell, many years ago, under the term " acute encephalitis of children " but it has only recently been recognized as a variety of poliomyelitis.

Ataxic Type.

The ataxic type, of which ataxia is a prominent symptom in most cases. In a few, it is the only nervous symptom, and in others, it is associated with paralysis of the cranial nerves or spinal paralysis. The ataxia is often of the cerebellar type.

Meningitic Type.

This type, with symptoms of meningeal irritation, often seen in the early stages of all types of poliomyelitis, but at times so marked that they simulate those of typical meningitis.

Polyneuritic Type.

The polyneuritic type, in which pain is often an especially prominent symptom, sometimes located in the joints but more frequently along the nerve trunks or indefinite in its distribution. This symptom may be so marked as to cause the paralysis to be entirely overlooked, the affection being mistaken for rheumatism or scurvy. The pain is usually most marked in the paralyzed parts, and the effect produced is that the extremities are often held rigidly and all motion is resisted because of the pain caused. Such rigidity and resistance is possible, of course, only when the muscles are partly paralyzed or some of them are intact, but if the significance of this peculiar combination of flaccidity and spasticity is not recognized, it may lead, in the acute stage, to diagnostic error.

Aside from a careful consideration of the general symptoms of the infection, and laboratory analysis of the spinal fluid on one or more occasions during the early or febrile stage of the disease, nothing gives so accurate a basis for diagnosis as a complete neurological examination of the patient.

The following is a list of symptoms and objective signs in the order of their frequency, as noted at the time of onset, in 1,500 cases studied with particular care.

Fever	806
Nausea and vomiting	476
Malaise and weakness	255
Headache	205
Constipation	148
Irritability	125
Diarrhoea	122
Coryza	78
Rigidity of neck	74
Tonsillitis	65
Pharyngitis	57
Peripheral pain	57
Muscular twitchings	57
Prostration	49
Convulsions	47
Cough	45

Among 338 cases at Queensboro Hospital, the cranial nerves were involved in 46 as follows:

Optic	2
Oculomotor	2
Pathetic	1
Abducens	12
Facial	26
Glossopharyngeal	2
Hypoglossal	1

Conjugate paralysis of the eyes was noted in 2 cases.

CHAPTER IX.

Diagnosis and Differential Diagnosis.

The diagnosis of poliomyelitis is rarely made conclusively before the appearance of the paralysis. When the paralysis has occurred, the diagnosis as a rule presents comparatively little difficulty, although even when paralysis is present the diagnosis is not always easy. Many cases are undoubtedly incorrectly diagnosed at the early stages of the disease, even when seen in the midst of an epidemic.

The principal symptoms which lead to a diagnosis of poliomyelitis have already been mentioned. They may be here divided into subjective and objective symptoms, and laboratory findings.

Under subjective symptoms may be listed: those following a history of exposure, including vomiting, pain, difficulty in swallowing, stiffness of the neck, weakness, and very often intestinal disturbances of some kind, pre-paralytic and pre-monitory diarrhoea, or constipation.

Under objective symptoms, those most frequently to be noticed are: fever, hyperesthesia, sweating, nervous irritability, stupor, rigidity, irregular breathing, dyspnoea, peculiar position of the child in bed, regional pains usually in the limbs affected, motor paralysis, or weakening, of erratic distribution, most marked in the extremities, especially the legs, and diminution or loss of muscular or tendon reflexes.

In doubtful cases of general infection presenting symptoms referable to the nervous system, particularly hyperesthesia, sweating and nervous irritability, recourse must be had to the examination of the cerebro-spinal fluid by lumbar puncture. This procedure is then warranted, and forms our most valuable laboratory aid in the diagnosis of poliomyelitis.

Differential Diagnosis.

In the first twenty-four to forty-eight hours after its onset, poliomyelitis must be differentiated from the early stages of epidemic meningitis or mild purulent meningitis, and also from a meningism accompanying pneumonia or other infection.

The clinical pictures presented by the above mentioned diseases are quite similar, and it is in distinguishing between them that the examination of the spinal fluid affords the most reliable information.

When seen a week or more after onset, cases of poliomyelitis, especially exhibiting cerebral symptoms, must be distinguished from tuberculous meningitis.

Though the differential diagnosis of selected cases of early purulent meningitis may be fairly easy, many cases fail to follow the typical description.

While epidemics of poliomyelitis usually occur in warm weather, and epidemics of meningitis in the winter or spring, sporadic cases of either occur at any time. A history of gastro-enteritis or an anginal attack, three to four days prior to the onset, is much more suggestive of poliomyelitis than of meningitis. A history of otitis media, an operation in the nose and throat, or a severe injury to the head, with possible fracture of the skull, makes one suspect a meningitis due, most likely, to the pneumococcus or streptococcus. The temperature of poliomyelitis is usually higher at the onset but falls more quickly than in meningitis. There is, ordinarily, greater hyperesthesia in poliomyelitis. The reflexes are more apt to be unequal, and the pupillary reflexes are very seldom lost. In meningitis, there is usually greater stiffness of the neck, and a more pronounced Kernig. Delirium is much more common than in poliomyelitis. A hemorrhagic eruption or herpes, if present, strongly suggests meningitis.

The differential diagnosis between poliomyelitis and meningism is far more difficult, until the underlying cause of the meningism develops. Even then we may be in doubt whether the pneumonia or gastro-enteritis, etc., may not be a complication of the poliomyelitis.

In differentiating poliomyelitis and tuberculous meningitis, it is to be noted that the onset is usually sudden in poliomyelitis and gradual in tuberculous meningitis, but some few cases of poliomyelitis give a history of gradual onset, and occasionally tuberculous meningitis begins abruptly. In the case of poliomyelitis resembling tuberculous meningitis, the stupor is not usually so profound. There is no projectile vomiting, and the pulse is usually more regular, while the temperature declines, and the progress of the case, after the first week or ten days, is generally toward recovery. Quite rarely in tuberculous meningitis, a paralysis may develop in the muscles of the eye. Sometimes other paralyses develop, as of the face or arms, but these are usually transitory.

In all these conditions, the differential diagnosis depends greatly on the result of the examination of the spinal fluid, but even here there are no pathognomonic findings. It is by ruling out other affections that it has its chief value, and it is of service only when correlated with a careful clinical study of the case.

Findings in the Spinal Fluid.

The spinal fluid in poliomyelitis is usually increased in amount and escapes under pressure. It is clear or slightly hazy in appearance and sometimes shows the fibrin web formation, which was formerly considered pathognomonic of tuberlous meningitis.

Bedside Tests.

Recently, attention has been drawn to the "ground glass" appearance (or a slight haziness seen in the fluid when viewed by a strong transmitted light) as being a help in diagnosing poliomyelitis. The appearance is caused

by the increased number of white blood cells (lymphocytes) which are distinctly visible to the naked eye, but better seen with the use of a pocket magnifying lens. It is found chiefly in the fluids containing a large number of cells, and is not so evident when the cells are few in number. The increased number of lymphocytes appear as dustlike particles uniformly suspended in the fluid. These particles can be put into motion by gently shaking the test tube containing the fluid. A normal spinal fluid, or a poliomyelitis fluid which has been standing for a number of hours, and in which the cells have settled to the bottom, does not exhibit this appearance unless the cells are distributed by shaking. It is clear and limpid, as a rule. The examination of the spinal fluid is best made in a dark room with the test tube held against an artificial light. This is not as accurate a test of cell increase as the exact cell count, but it is of practical value as a bedside test.

Any bedside test by which cases of poliomyelitis can be diagnosed during the early stages of the disease is important, both for purposes of isolation and control of infection, and for treatment of the patient. Several precautions, however, must be observed in utilizing this test. First, there must be no red blood cells in the spinal fluid. Red blood cells, if only a few in number, can be distinguished macroscopically by the appearance of the fluid, and the opalescence produced by these cells may be mistaken for that caused by white blood cells. When more numerous, the red blood cells are recognized by a characteristic yellowish shimmer in the fluid. A subsequent microscopic examination should, at any rate, always be made to exclude the presence of red blood cells.

The white blood cells (lymphocytes and polynuclears) are also found increased in the spinal fluid in other conditions, especially tuberculous meningitis, epidemic cerebro-spinal meningitis, syphilitic involvement of the meninges and vessels of the brain, etc. This macroscopical ground glass appearance of the spinal fluid in poliomyelitis, therefore, cannot be said to be pathognomonic, but as a bedside test, provided the precautions above mentioned are taken, it is of diagnostic value during an epidemic. The use of a miscroscope at the bedside is invaluable for prompt diagnosis of spinal fluids in the field during epidemics of poliomyelitis.

In the later stages of poliomyelitis, generally after the seventh to the tenth day, the cells in the spinal fluid rapidly decrease in number and soon reach a normal count. In these later stages of the disease it is often important to establish a diagnosis, especially where no paralytic symptoms have appeared. A simple and fairly accurate method of diagnosing these cases is to remove the spinal fluid by lumbar puncture and examine its albumin and globulin content. A majority of persons who have had an attack of poliomyelitis will show an increased amount of both these substances for a period of eight to ten weeks. During an epidemic, especially, after a history of some or all of the pre-paralytic symptoms of poliomyelitis, such increase is strongly suggestive of an initial attack.

The attached table illustrates rather strikingly the persistence of the albumin increase (the globulin content generally runs parallel with that of the albumin), even as late as eight weeks after the onset of symptoms. It is interesting to note that the maximum quantity of albumin is found in a larger proportion of cases during the second, rather than the first week of the disease. In the table, + + + indicates the maximum, ± the normal amount. In this manner it is often possible to clear up the diagnosis of some non-paralytic types of poliomyelitis even during the later stages of the disease.

Albumin Content of Spinal Fluids in Poliomyelitis.

Days Ill.	Total No. Spinal Fluids.	+++	%	++ 1 and ++	%	+ 1 and +	%	±	%
1– 7.....	52	8	15.4	22	42.3	18	34.6	4	7.7
7–14.....	39	20	51.3	10	25.6	6	15.4	3	7.7
14–21.....	35	12	34.2	7	20.0	11	31.4	5	14.3
21–28.....	31	8	25.8	12	38.7	7	22.6	4	12.9
28–35.....	26	3	11.5	4	15.4	14	53.9	5	19.2
35–42.....	37	1	2.7	8	21.6	18	48.7	10	27.0
42–49.....	51	4	7.8	14	27.5	20	39.2	13	25.5
49–56.....	50	2	4.0	11	22.0	26	52.0	11	22.0
Total.....	319								

+++ Maximum.
++ 1, ++ Large amount.
+ 1, + Moderate amount.
± Normal amount.

In addition to the ground-glass appearance of the fluid, before mentioned as being of value in the early stages, there is another macroscopic test which may be used both early and late in the disease. This is the so-called "foam test," which depends upon the pathologically increased quantity of albumin and globulin in the spinal fluids of cases of poliomyelitis. When a test tube is half filled with spinal fluid and throughly shaken, a persistent foam appears on the surface, which may last from one-half to one hour, or longer. The foam thus produced in poliomyelitis is much denser, more voluminous and more peristent than that obtained with normal spinal fluid, but here also the presence of blood must be excluded before making any definite deductions from this test.

The needle best adapted for diagnostic punctures has been found to be one of No. 18 gauge and not longer than three inches. Such a needle is easily handled, does not bend, causes little trauma and very little pain. With the patient placed in the proper recumbent position and the back well arched, the needle is introduced almost vertically, but with a slight upward direction, in the median line betwen the third and fourth lumbar vertebrae on a level with the crest of the ileum. Anaethesia, local or general, is unnecessary as a rule. But when the child struggles considerably, and the examination of the spinal fluid is of great importance to clear up the diagnosis, a light ether anaesthesia, for a few minutes, is justifiable.

Laboratory Examination.

A more complete examination of the spinal fluid must be made in the laboratory, to obtain conclusive results.

As before alluded to, the spinal fluid in poliomyelitis shows evidence of an inflammatory reaction; there is a varying increase in the cells and in the albumin and globulin. In some of the cases, this evidence of inflammatory reaction is well marked; in most cases it is very moderate, while in a few cases, at the other extreme, it is so slight and the fluid produced so nearly normal, that it is very difficult to make a definite statement regarding the findings. In these cases, laboratory technique must be resorted to, to obtain reliable results. The technique employed in examining the spinal fluids in the Research Laboratory of the Department is as follows:

All clear or slightly clouded fluids are centrifuged at high speed for an hour. From the sediment spreads are made, taking care to use as nearly as possible the same area on the different slides. The sediments or clear fluids are stained by the Ziehl-Nielsen method for the tubercle bacillus, the sediment of slightly cloudy fluids are stained both for the tubercle bacillus and by the Gram method. Smears from the poliomyelitis fluids are also stained by special blood stains, in order to study the cells. From this stained sediment we can estimate the increase in cells as slight, moderate, great, or very great. We can also estimate from these stained sediments the percentage of mononuclear and polymorphonuclear cells and note the presence of endothelioid and polyform cells. The presence or absence of bacteria is likewise noted. Cultures are made from all specimens. Uncontaminated poliomyelitis fluids have been found uniformly negative.

The chemical tests used are the nitric acid ring test for albumin, and the Noguchi butyric acid test for globulin. The small amount of albumin and globulin present in the normal fluids is marked, ±, +, +1, ++, ++1, +++, etc., representing increasing amounts, and serves as a rough quantitative estimation of the albumin and globulin. The presence of glucose is tested by using an equal amount of Fehling's solution and spinal fluid, and it is marked according to the speed and the amount of reduction as —, ±, +, ++, +++. The globulin reaction and reduction of Fehling's solution should not be read for at least half an hour.

Taking up these points more in detail, the cytology must first be considered. The increase in cells varies greatly, both in different cases and in the stage at which the puncture is made. Our counts have varied from slightly above normal, that is, from 15 to 20, to 1,000 or more. The counts tend to fall off after the first week and by the end of the second week have dropped to practically normal, in nearly all instances.

The cells usually show a preponderance of mononuclears, but, in a few cases there are over fifty per cent. of polymorphonuclears. It has been stated by some that early in the disease there is an excess of polymor-

phonuclears, which later are replaced by mononuclears. We found, in an examination of 1,500 fluids, many of which were taken in the 2nd, 3rd and 4th days of the disease, that the polynuclears predominated only in 39 cases, in these instances the fluids being collected on days of the disease from 2nd to 27th. The polymorphonuclears, therefore, in our opinion, represent a definite type of reaction, not a stage of the disease. Often, even in the fresh fluids, the cells are so degenerated that it is difficult to classify them. There have been found large mononuclear cells apparently endothelioid in type that seem to occur more frequently in poliomyelitis than in other conditions. The so-called polyform cells are also found.

Albumin and globulin, as before stated, are usually increased slightly to moderately. Fehling's solution is practically always well reduced. The fluids that show a poorer reduction are usually those with the larger amount of albumin and globulin.

Differential Diagnosis of Spinal Fluids.

Slightly cloudy fluids in poliomyelitis must be differentiated from those in early cases of purulent meningitis, and from the slightly cloudy fluid that occasionally occurs in tuberculous meningitis. The clear or practically clear fluids must be distinguished from rare early cases of purulent meningitis, tuberculous meningitis, syphilis of the central nervous system, especially acute syphilitic meningitis, and meningism. Other rarer conditions might be mentioned, but these are the most important.

In the early cases of *purulent meningitis,* the spinal fluid shows a varying degree of cloudiness, except in very rare instances, when it may be clear. A greater increase in albumin and globulin is usually found here than occurs in poliomyelitis, with a poorer reduction of Fehling solution. The cells, in these fluids of purulent meningitis, are ninety per cent. or more polynuclears, and the etiological organism is always found, except in the mildest cases. In certain mild cases of meningitis, probably of the epidemic variety, the meningococci may never be positively demonstrated in the fluid. In purulent meningitis, due to other organisms, these practically always appear later. In one instance only have we seen a clear fluid from an early case of epidemic meningitis of about eighteen hours' duration. Although the cellular reaction was so slight, the meningococcus was demonstrated to be present in the fluid by smear and culture.

The fluid in *tuberculous meningitis* most nearly resembles that of poliomyelitis. It is practically always clear, with a cellular increase consisting largely of mononuclears, though in very acute cases the fluid may be distinctly cloudy with an excess of polymorphonuclears. Fortunately, in these cases, the tubercle bacillus is usually easy to demonstrate. The number of cells, per cubic millimeter, is usually greater than in poliomyelitis; the increase in albumin and globulin is more marked, and the reduction of Fehling's solution is not so great.

In rare instances, when clinical signs are confusing, when the results of the cellular examination and chemical analysis are indefinite, and it is impossible to demonstrate tubercle bacillus in the fluid, a positive diagnosis must wait upon the results of animal inoculation.

The fluid of an acute *syphilitic meningitis* closely resembles the fluid of poliomyelitis, and the clinical signs are also confusing. The Wassermann reaction is the best method of differentiating the two conditions. Of course, a positive Wassermann would not rule out a poliomyelitis in an old syphilitic condition, but this, combined with the clinical conditions and the progress of the case, makes one reasonably sure of the diagnosis. It was suggested at first that the products of degeneration present in the spinal fluid of poliomyelitis cases might give a non-specific Wassermann reaction. Tests, in about three hundred and fifty cases, have proved this not to be true.

The fluid of *meningism* is clear, increased in amount, and practically always normal in character. The few exceptions to this, found in examining a large number of cases, have fallen commonly into three groups: fluids from cases with prolonged and severe convulsions; fluids in severe whooping cough; and fluids removed just prior to death. In these cases there has sometimes occurred an increase in cells, or in globulin or albumin, or both. In convulsions there is probably edema, in whooping cough, minute hemorrhages, and just before death, circulatory changes to account for it.

Two rare types of spinal fluids sometimes occur in poliomyelitis, when the hemorrhagic process has been more than usually severe. The first of these is of the true hemorrhagic character, the red blood cells being evenly diffused throughout the fluid. When collected in successive tubes, the specimens are all homogeneous, showing no change in the intensity of the hemorrhage. This serves to differentiate it from bloody fluids obtained by the accidental puncture of a vein. Evidence of an older hemorrhagic condition occurs in the second of these rarer fluids, which having a characteristic yellow color and coagulating spontaneously, illustrates the so-called syndrome of Froin. These fluids occur in other conditions and are therefore not pathognomonic of poliomyelitis.

Two thousand poliomyelitis fluids were examined at the Research Laboratory of the Department, but only five hundred of these were carefully studied. Statisticians state that results based on five hundred specimens, and results based on two thousand or more, would, to all intents and purposes, be the same. It seemed better, therefore, to take this smaller number and make careful studies of them, rather than to attempt to use a larger number of specimens and study the data less thoroughly.

Tables on pages 228-231 inclusive, show the findings obtained in the laboratory examination of spinal fluids in poliomyelitis cases.

Colloidal Gold Test.

Lange's Colloidal Gold Test,* in the hands of some of our workers, has been helpful in differentiating the fluids of poliomyelitis from those of tuberculous meningitis, and from the fluids of meningism, which are not normal in character. This test is as follows:

Into the first of eleven test tubes put 0.9 c. c. of fresh, sterile 0.4% NaCl solution. Into each of remaining tubes put 0.5 c. c. of the 0.4% NaCl solution. Add to the first tube 0.1 c. c. of the spinal fluid to be tested. Mix well.

Transfer 0.5 c. c. of the resultant 1 to 10 dilution of spinal fluid to the second tube. Mix well.

Transfer 0.5 c. c. of the resultant 1 to 20 dilution of spinal fluid to the third tube. Mix well.

Proceed in this manner up to and including the eleventh tube.

By this method a series of dilutions of spinal fluid is secured, in geometrical progression, ranging from 1 to 10, to 1 to 5,120.

Now add to each tube 2½ c. c. of Colloidal Gold solution.

Shake each tube thoroughly and do not read for 12 hours.

The various types of color changes seen in the positive gold reaction are indicated by numerals as follows:

Complete decolorization	5
Pale blue	4
Blue	3
Lilac or purple	2
Red-blue	1
Brilliant red-orange—normal color	0

A normal fluid would remain brilliant red-orange color and would, therefore, read 00000000000 or a very slight reaction 11100000000.

A poliomyelitis fluid (as found in 78 cases of positive poliomyelitis) would remain brilliant red-orange color in the first two tubes, slightly bluish in third, purple in fourth tube and again bluish in fifth, returning to normal

*Note—Zsigmondy following an exhaustive study of the subject of the "coagulating" action of electrolytes, or metallic colloidal solution, was able to find a definite measure of the protective action of certain colloids, especially proteins, on the precipitation of gold suspensions by sodium chloride. The degree of protection was specific for each protein he examined. By using this general method he was enabled to distinguish between luetic and normal sera. Lange proceeded further, and found that normal spinal fluids, suitably diluted with a four per cent. solution of sodium chloride, caused no alkalination in suitable solutions of colloidal gold, and abnormal spinal fluids caused partial or complete precipitation of colloidal gold with resultant color changes occurring in curves, which tend to be almost specific for certain diseases, particularly those of luetic origin. This specificity is characterized by maximal color changes within dilution zones. Fluids from different types of meningitis give reactions with greatest intensity in higher dilutions. Paretic fluids cause complete flocculation in the first four to six dilutions. Tabes and cerebro-spinal lues give maximal reactions in fourth to fifth dilutions. We have Lange's results in 105 fluids. Lange's results agree with our clinical and laboratory diagnoses in 103 cases.—*Bul. Johns Hopkins Hospital, XXVI, No.* 298.

red-orange in sixth tube, and would, therefore, read approximately 00123000000.

Two hundred positive poliomyelitis fluids tested by the Lange gold reaction in the State Department of Health showed the following values: 11122110000, and there were readings varying all the way from 11110000000 to 12321000000.

In other words, the readings given cannot be considered absolute, and the emphasis may shift to the right or left, within moderate limits, but in the main the usual reading corresponds with the readings in a weak luetic spinal fluid.

A meningitis fluid unchanged in first two tubes and ranging from this to colorless in the ninth tube and back to original in the eleventh tube, approximately 00112234531.

Curves showing these typical reactions and readings are given on pages 211 and 213.

Curve I shows the result obtained in Paretic, Meningitic and Luetic spinal fluids.

Curves II and VII show various poliomyelitis readings.

Chart VIII is the composite of II to VII, giving the average curve for 90 fluids.

Quantitative Chemical Studies in Spinal Fluids.

Quantitative studies in spinal fluids of poliomyelitis and various forms of meningitis have been undertaken in the Research Laboratory, with the hope that these studies would throw some light either on the diagnosis or prognosis of these diseases. The determinations attempted embrace total non-protein, urea and ammonia nitrogen, uric acid, creatinine, creatine, sugar and cholesterol. The methods employed were adaptations, and in some cases, modifications of the micro-chemical procedures so extensively used in blood investigations.

Only blood-free fluids were used in these determinations. It might be said, however, that water clear spinal fluids which, on centrifuging, show a fine grayish-white sediment appearing to be totally free from blood, occasionally on microscopic count show the presence of several red cells per c. c. It seems to be impossible to pass through the skin and subcutaneous tissues in a lumbar puncture without taking up a few red cells, and these appear to be insignificant so far as the chemical determinations are concerned.

With the exception of urea, which has been extensively studied by French workers (1), quantitative studies in spinal fluids are comparatively meager, due undoubtedly to the fact that until recently, micro-methods not being available for these determinations, any single chemical test required relatively large quantities of spinal fluid and this was not often available.

(1) Soper and Granat, Arch. Int. Med., XIII, 131, 1914, review the literature.

According to Plaut, Rehm and Schottmüller, (2) normal spinal fluid contains from 30 to 60 mgm. of protein per 100 c. c. These figures are increased in various diseases extending in meningitis as high as 250 mgm. per 100 c. c. More recent workers(3) report in syphilitic and other pathological conditions quantities of protein extending from 20 to 100 mgm. per 100 c. c. of fluid. Total nitrogen in spinal fluids ranges, according to Rosenbloom,(4) from 162 to 362 mgm. per 100 c. c. Woods(5) finds the non-protein nitrogen in spinal fluid about 25 per cent. less than that found in the blood, *i. e.*, about 20 mgm. per 100 c. c. of fluid. This is in agreement with that reported by other workers(6). The concentration of urea in this fluid, on the other hand, appears to be equal to that of the blood(7). In nephritis, Fine and Myers(8) found that the concentration of creatinine in spinal fluid is 46 per cent. of that in the blood; of creatine, 22 per cent. and of uric acid, 5 per cent of the respective concentrations of the blood.

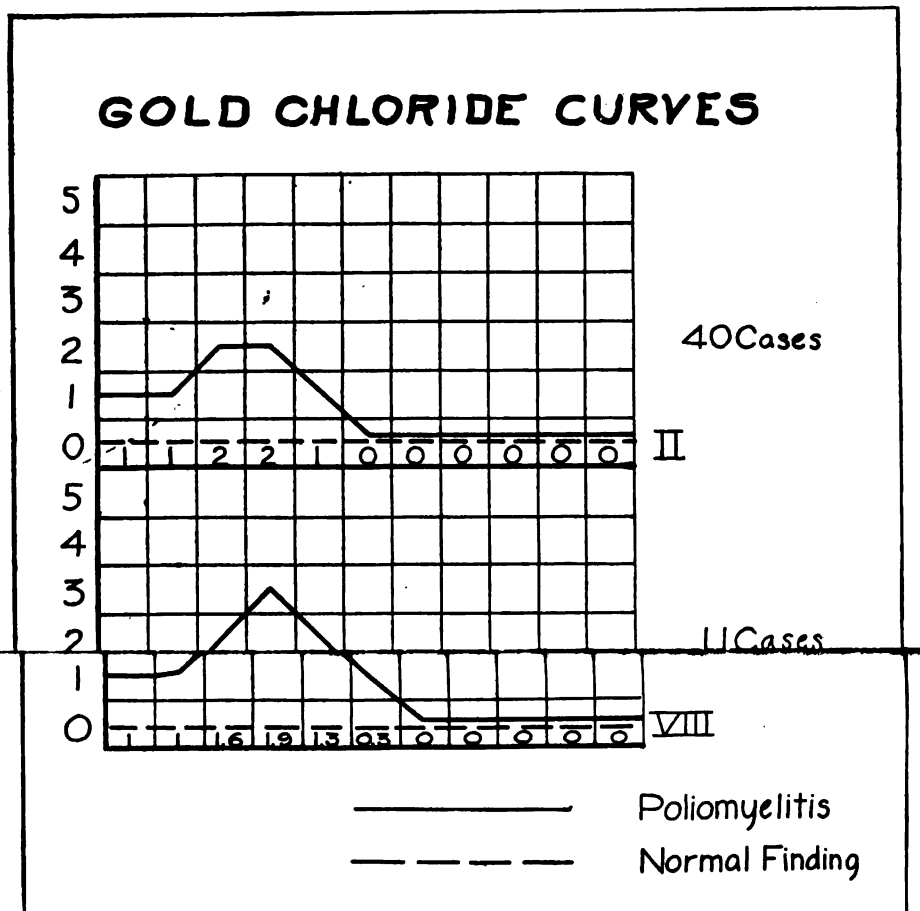
Schloss and Schroeder(9) recently studied the sugar content in spinal fluids of infants and children, and found that in cases free from meningeal diseases the sugar ranged from .05 to .134 per cent. In cases of meningitis these figures were considerably decreased. The presence of cholesterol in spinal fluids has been reported by various workers(10) in different forms of paralysis.

Total Nitrogen.

The method employed for the determination of total nitrogen in spinal fluids was a modification of the direct Nesslerization method recently developed by Folin and Denis(11). The modification in detail is presented in another place(12). In this connection, only a brief outline of the procedure will be given.

> Two c.c. of spinal fluid are pipetted into a test tube, 1 c.c. of the concentrated acid mixture (containing 1 volume concentrated sulphuric acid, 3 volumes concentrated phosphoric acid and one fifteenth volume of a 10 per cent. solution of copper sulphate) added and the digestion carried out over a micro-burner until the appearance of white sulphuric acid fumes; the mouth of the test tube is then covered with a watch glass and heating continued for about a minute. The color obtained is usually straw yellow. After permitting the test tube to cool, the contents are rinsed quantitatively into a 100 c.c. volumetric flask, using about 60 c.c. of water in the process. A quantity of 10 per cent. sodium hydroxide is then added, sufficient

(2) Leitfaden zur Untersuchung der Zerebrospinal flüssigkeit, Jena, 1913, p. 16.
(3) Pfeiffer, Kober, and Field, Proceed. Soc. Exp. Biol. and Med., XII, 153, 1915.
(4) Rosenbloom, Biochemical Bulletin, V. 24, 1916.
(5) Woods, Arch. Int. Med., XVI, 577, 1915.
(6) Millard and Proment, Journ. de Physiol et de Path. General, XI, 263, 1909.
(7) Cullen and Ellis, Journ. Boil. Chem. XX, 511, 1915.
(8) Fine and Myers, Proceedings Society for Exp. Biol. and Med., XIII, 70, 1916.
(9) Schloss and Schroeder, Amer. Jour. Dis. of Child., XI, 1, 1916.
(10) Pithini, Zeitsch. f. Phys. Chem., 61, 508. 1909.
(11) Folin and Denis, Journ. Biol. Chem., XXVI, 473, 1916.
(12) Kahn, Journ. Biol. Chem., XXVIII, 203, 1916.


GOLD CHLORIDE CURVES
5
4
3
2
1
0
1 1 2 2 1 0 0 0 0 0 0
II
40Cases
5
4
3
2
1
0
1 1 1.6 1.9 1.3 0.5 0 0 0 0 0
VIII
11Cases
Poliomyelitis
Normal Finding